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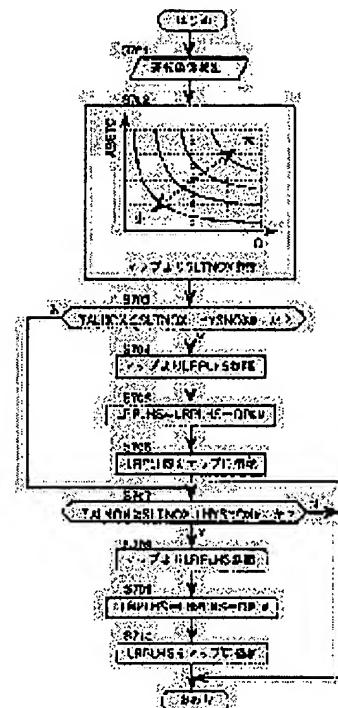
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(54) AIR-FUEL RATIO CONTROL DEVICE OF INTERNAL COMBUSTION ENGINE

(57)Abstract:

PROBLEM TO BE SOLVED: To deoxidize NO_x desorbed from a NO_x adsorption catalyst by making the NO_x properly rich corresponding to the desorption quantity of NO_x at the time of transition from the lean burn to stoichiometric burn.

SOLUTION: The target SLTNOX of NO_x quantity discharged at the time of transition from lean burn to stoichiometric burn is set according to the NO_x adsorption quantity ABSTC and intake air quantity Q during lean combustion (S702). The target SLTNOX is compared with the actual NO_x discharge quantity TALNOX (S703, S707) and rich degree LRPLHS is learned in such manner that the actual NO_x discharge quantity TALNOX is restrained within the range of the target SLTNOX \pm designated value HYSNOX# (S704-S706, S708-S710).



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CLAIMS

[Claim(s)]

[Claim 1] The air-fuel ratio control system of the internal combustion engine which comes to prepare for a flueway the NOx adsorption catalyst which is characterized by providing the following, and which is desorbed from NOx which adsorbed NOx under exhaust air in RIN air-fuel ratio atmosphere, and carried out [aforementioned] adsorption in the air-fuel ratio atmosphere below theoretical air fuel ratio rather than theoretical air fuel ratio. The rich-ized means into which an air-fuel ratio is made to turn richly rather than a target air-fuel ratio temporarily [when it shifts to the operating range burned near theoretical air fuel ratio from the operating range burned in the aforementioned RIN air-fuel ratio]. A NOx concentration detection means to detect the NOx concentration under exhaust air in the downstream of the aforementioned NOx adsorption catalyst, and rich-ized degree control means which control the rich-ized degree by the aforementioned rich-ized means according to the NOx concentration under exhaust air detected with this NOx concentration detection means.

[Claim 2] The air-fuel ratio control system of the internal combustion engine according to claim 1 characterized by learning the rich-ized degree which the aforementioned rich-ized degree control means controlled by the engine load and engine rotational speed based on the detection value of NOx concentration for every operating range classified into plurality.

[Claim 3] An inhalation air-content detection means by which the aforementioned rich-ized degree control means detect an engine's inhalation air content, It is based on the inhalation air content detected with this inhalation air-content detection means, and the NOx concentration under exhaust air detected with the aforementioned NOx concentration detection means. A NOx discharge calculation means to compute the total amount of the NOx discharge in the predetermined period immediately after shifting to the operating range burned near theoretical air fuel ratio from the operating range burned in the aforementioned RIN air-fuel ratio, The air-fuel ratio control system of the internal combustion engine according to claim 1 or 2 characterized by controlling the rich-ized degree by the aforementioned rich-ized means based on the total amount of the NOx discharge which consisted of ***** and was computed with this NOx discharge calculation means.

[Claim 4] It has a NOx amount-of-adsorption calculation means to compute the total amount of the NOx amount of adsorption by which the aforementioned NOx adsorption catalyst was adsorbed in the operating range burned in the aforementioned RIN air-fuel ratio. The total amount of the NOx amount of adsorption by which the aforementioned rich-ized degree control means were computed with the aforementioned NOx amount-of-adsorption calculation means, The air-fuel ratio control system of the internal combustion engine according to claim 3 characterized by controlling the rich-ized degree by the aforementioned rich-ized means based on the total amount of the NOx discharge computed with the aforementioned NOx discharge calculation means.

[Claim 5] The air-fuel ratio control system of the internal combustion engine according to claim 4 characterized by controlling the rich-ized degree by the aforementioned rich-ized means so that the total amount of the NOx discharge computed by the desired value of the total amount of the NOx discharge which the aforementioned rich-ized degree control means set up based on the total amount and inhalation air content of the NOx amount of adsorption which were computed with the aforementioned NOx amount-of-adsorption calculation means with the aforementioned NOx discharge calculation means may approach.

[Claim 6] The air-fuel ratio control system of the internal combustion engine according to claim 4 or 5 characterized by the aforementioned rich-ized degree control means correcting the basic rich-ized degree based on the total amount of the NOx amount of adsorption computed with the aforementioned NOx amount-of-adsorption calculation means based on the total amount of the NOx discharge computed with the aforementioned NOx discharge calculation means.

[Claim 7] The air-fuel ratio control system of the internal combustion engine of any one publication of the claim 4-6 characterized by making a period until the integrated value of an inhalation air content with the aforementioned NOx

discharge calculation means actual to the addition desired value of the inhalation air content set up based on the NOx amount of adsorption computed with the aforementioned NOx amount-of-adsorption calculation means reaches into the predetermined period which computes the total amount of the aforementioned NOx discharge.

[Claim 8] It has an air-fuel ratio feedback control means to control the air-fuel ratio of a gaseous mixture by proportionality and the integral control at least. in the operating range burned near theoretical air fuel ratio, an actual air-fuel ratio is brought close to a target air-fuel ratio -- as -- engine inhalation -- the proportionality control input of the direction [in / the aforementioned air-fuel ratio feedback control means / in the aforementioned rich-ized means] of rich-izing -- an increase amendment -- by things The air-fuel ratio control system of the internal combustion engine of any one publication of the claim 1-7 characterized by stopping increase amendment of the aforementioned proportionality control input temporarily when it is the composition made to turn richly from a target air-fuel ratio about an air-fuel ratio and 1 control period by the aforementioned air-fuel ratio feedback control means was completed.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention has in detail the NOx adsorption catalyst which adsorbs NOx in an engine flueway about the air-fuel ratio control system of an internal combustion engine, and relates to the AFC technology for making the aforementioned NOx purification perform proper in the system which NOx by which this NOx adsorption catalyst was adsorbed is made to react with HC and CO in the state of the combustion below theoretical air fuel ratio, and purifies it.

[0002]

[Description of the Prior Art] Conventionally, there were some which are indicated by JP,6-129246,A as an internal combustion engine equipped with the aforementioned NOx adsorption catalyst. When this thing equips a flueway with the NOx adsorbent which emits NOx absorbed when the air-fuel ratio of inflow exhaust air was RIN, and NOx was absorbed and it became rich and it shifts to operation near theoretical air fuel ratio from RIN operation, after making an air-fuel ratio rich temporarily, it is the composition carried out near theoretical air fuel ratio, and it has become with the composition which controls the aforementioned rich-ized degree or the period of rich-izing based on the amount of NOx(es) stored in the NOx adsorbent.

[0003] According to this composition, only HC corresponding to the amount of NOx(es) emitted with the shift to operation near theoretical air fuel ratio from RIN operation can be secured, with NOx can be purified good.

[0004]

[Problem(s) to be Solved by the Invention] however -- since it was composition without a means to judge whether the aforementioned rich-ized degree is proper with the above-mentioned conventional equipment, a rich-ized degree is superfluous in not demonstrating the NOx reduction effect by rich-izing as a demand -- becoming -- exhaust air -- there was *** which worsens a character and mpg

[0005] namely, when the different amount of NOx(es) from the amount of NOx(es) predicted by the case where it is not controlled by the rich air-fuel ratio corresponding to rich-ized control, dispersion of a NOx adsorbent, etc. is emitted Even if it controls a rich-ized degree based on the amount of NOx(es) stored in the NOx adsorbent This rich-ized degree does not serve as a proper amount, but HC discharge increases that rich-izing is superfluous, and make mpg get worse, and conversely, if too little [rich-izing] The purification performance of NOx falls and it becomes impossible to suppress a NOx discharge below on demand level (refer to drawing 15).

[0006] Even if the air-fuel ratio used as the base is on the RIN side from the first and it performs rich-ization, when [when not controlled by the rich air-fuel ratio corresponding to rich-ized control, for example,] it becomes RIN from a desired value and sufficient HC cannot be supplied by property dispersion of a product etc., conversely, the base air-fuel ratio is on the rich side, and is the case where turn and excessive HC is discharged, richly from a request. Although air-fuel ratio learning control is known as technology which cancels rose ***** of the aforementioned base air-fuel ratio here At the time of the shift to the acceleration state which is the typical pattern which shifts to theoretical-air-fuel-ratio operation from RIN operation Since the state of the fuel which it was easy to produce the measurement error of an inhalation air content, and has adhered to the suction-port wall surface also changes a lot, in the aforementioned air-fuel ratio study with an eye on the air-fuel ratio stability at the time of a stationary the base air-fuel ratio when shifting to theoretical-air-fuel-ratio operation from RIN operation cannot be amended with high precision, but expected is rich by rich-ized control as a result -- the case where a gaseous mixture cannot be formed arises

[0007] Moreover, since there was dispersion also in the adsorption capacity force of a NOx adsorbent, or a discharge operation, even if it was the case where an error might arise in presumption of the amount of adsorption, and there was no error in presumption of the amount of adsorption, it was difficult to control to the rich-ized degree which dispersion might occur in the burst size and corresponded with a sufficient precision to the amount of NOx(es). In addition,

although equipment has the indication of composition of detecting HC concentration in the downstream of a NOx adsorbent, and detecting completion of a NOx discharge operation, with terminating rich-ization conventionally [aforementioned] mpg and exhaust air according [since the state where the amount of HC exceeds the specified quantity by unnecessary rich-ization after a NOx discharge operation end also in this case is detected, cannot control the rich-ized degree under NOx discharge the optimal, and] to rich-izing superfluous as a result -- there is **** which causes aggravation of a character

[0008] It aims at enabling it to avoid increase of the amount of HC, and aggravation of mpg, enabling it to perform stably the optimal rich-ized control for reduction of NOx, with suppressing a NOx discharge certainly, even if this invention is made in view of the above-mentioned trouble and has dispersion in a base air-fuel ratio, and dispersion of a NOx adsorbent.

[0009]

[Means for Solving the Problem] Therefore, invention according to claim 1 is constituted as shown in drawing 1 . In drawing 1 , rather than theoretical air fuel ratio, a NOx adsorption catalyst adsorbs NOx under exhaust air in RIN air-fuel ratio atmosphere, it is a catalyst desorbed from NOx which carried out [aforementioned] adsorption in the air-fuel ratio atmosphere below theoretical air fuel ratio, and a flueway is equipped with it.

[0010] A rich-ized means makes an air-fuel ratio turn richly rather than a target air-fuel ratio temporarily, when it shifts to the operating range burned near theoretical air fuel ratio from the operating range burned in the aforementioned RIN air-fuel ratio. On the other hand, a NOx concentration detection means detects the NOx concentration under exhaust air in the downstream of the aforementioned NOx adsorption catalyst.

[0011] And rich-ized degree control means control the rich-ized degree by the aforementioned rich-ized means according to the NOx concentration under exhaust air detected with the NOx concentration detection means. When according to this composition it shifts to the operating range burned near theoretical air fuel ratio from the operating range burned in the aforementioned RIN air-fuel ratio and NOx is desorbed from a NOx adsorption catalyst, an air-fuel ratio is turned richly positively and reservation of the amount of HC needed for reduction processing of NOx is aimed at. It considered as the composition controlled so that NOx concentration is supervised since HC concentration increases, although NOx concentration falls greatly that a rich-ized degree is excessive while NOx concentration becomes large, without the ability returning NOx good as too little [a rich-ized degree] here, and the aforementioned rich-ized degree becomes proper.

[0012] In invention according to claim 2, it considered as the composition which learns the rich-ized degree which the aforementioned rich-ized degree control means controlled by the engine load and engine rotational speed based on the detection value of NOx concentration for every operating range classified into plurality. According to this composition, since the rich-ized degree which is classified into plurality with an engine load and engine rotational speed and as for which NOx concentration is made to a proper value for every operating range is learned, even if service conditions differ, it is avoidable that can control NOx concentration low stably and the amount of HC increases by superfluous rich-ization.

[0013] An inhalation air-content detection means by which the aforementioned rich-ized degree control means detect an engine's inhalation air content in invention according to claim 3, It is based on the inhalation air content detected with this inhalation air-content detection means, and the NOx concentration under exhaust air detected with the aforementioned NOx concentration detection means. A NOx discharge calculation means to compute the total amount of the NOx discharge in the predetermined period immediately after shifting to the operating range burned near theoretical air fuel ratio from the operating range burned in the aforementioned RIN air-fuel ratio, It considered as the composition which controls the rich-ized degree by the aforementioned rich-ized means based on the total amount of the NOx discharge which consisted of ***** and was computed with this NOx discharge calculation means.

[0014] Superfluous rich-ization can be avoided, avoiding that a NOx discharge comes to exceed an allowed value according to this composition. In the operating range burned with the aforementioned RIN air-fuel ratio in invention according to claim 4 The total amount of the NOx amount of adsorption equipped with a NOx amount-of-adsorption calculation means to compute the total amount of the NOx amount of adsorption by which the aforementioned NOx adsorption catalyst was adsorbed by which the aforementioned rich-ized degree control means were computed with the aforementioned NOx amount-of-adsorption calculation means, It considered as the composition which controls the rich-ized degree by the aforementioned rich-ized means based on the total amount of the NOx discharge computed with the aforementioned NOx discharge calculation means.

[0015] When the NOx discharges permitted, for example according to the total amount of the NOx amount of adsorption differ according to this composition, it becomes controllable corresponding to the demand of a rich-ized degree which becomes possible [controlling to the suitable rich-ized degree corresponding to this demand], and is different according to the NOx amount of adsorption beforehand. In invention according to claim 5, it considered as

the composition which controls the rich-ized degree by the aforementioned rich-ized means so that the total amount of the NOx discharge computed by the desired value of the total amount of the NOx discharge which the aforementioned rich-ized degree control means set up based on the total amount and inhalation air content of the NOx amount of adsorption which were computed with the aforementioned NOx amount-of-adsorption calculation means with the aforementioned NOx discharge calculation means might approach.

[0016] According to this composition, the total amount of the NOx discharge permitted based on the total amount and inhalation air content of the NOx amount of adsorption will be set up as desired value, and proper rich-ization to which an actual discharge serves as this desired value will be performed. In invention according to claim 6, it considered as the composition whose aforementioned rich-ized degree control means correct the basic rich-ized degree based on the total amount of the NOx amount of adsorption computed with the aforementioned NOx amount-of-adsorption calculation means based on the total amount of the NOx discharge computed with the aforementioned NOx discharge calculation means.

[0017] According to this composition, fundamentally, since the time with much NOx amount of adsorption needs to enlarge a rich-ized degree, before the correction based on the total amount of a NOx discharge is made, even if it is, it is controllable to the rich-ized degree which balanced the amount of adsorption at least. In invention according to claim 7, it considered as the composition which makes a period until the integrated value of an inhalation air content with the aforementioned NOx discharge calculation means actual to the addition desired value of the inhalation air content set up based on the NOx amount of adsorption computed with the aforementioned NOx amount-of-adsorption calculation means reaches the predetermined period which computes the total amount of the aforementioned NOx discharge.

[0018] The total amount of NOx which set up the period until the integrated value of an actual inhalation air content reaches the desired value which according to this composition set up the time with much NOx amount of adsorption based on the NOx amount of adsorption since desorption of adsorbed NOx would take a long period as a period which calculates the total amount of a NOx discharge, and was desorbed from it can be calculated with a sufficient precision. In the operating range burned near theoretical air fuel ratio in invention according to claim 8 It has an air-fuel ratio feedback control means to control the air-fuel ratio of a gaseous mixture by proportionality and the integral control at least. an actual air-fuel ratio is brought close to a target air-fuel ratio -- as -- engine inhalation -- the proportionality control input of the direction [in / the aforementioned air-fuel ratio feedback control means / in the aforementioned rich-ized means] of rich-izing -- an increase amendment -- by things Temporarily, when it is the composition made to turn richly from a target air-fuel ratio about an air-fuel ratio and 1 control period by the aforementioned air-fuel ratio feedback control means was completed, it considered as the composition which stops increase amendment of the aforementioned proportionality control input.

[0019] Since increase amendment of a proportionality control input is stopped when the stage, i.e., 1 control period, where the air-fuel ratio which turned richly temporarily returns near a target air-fuel ratio gradually, and proportional control is again performed in the direction of rich-izing by increase amendment of a proportionality control input is ended according to this composition, it can be made to change from a rich-ized control state to the state near a target air-fuel ratio smoothly.

[0020]

[Embodiments of the Invention] The gestalt of operation of this invention is explained below. Drawing 2 is drawing showing the system configuration of the internal combustion engine in this operation gestalt. In this drawing 2 , the air through the air cleaner 2 is controlled [the flow of / it] and attracted by the internal combustion engine 1 by the throttle valve 3.

[0021] The fuel by which injection supply is carried out from the fuel injection valve 4 infixd in the suction port of each cylinder is mixed with the aforementioned air, a gaseous mixture is formed, and ignition combustion of the gaseous mixture attracted in the cylinder is carried out by jump spark ignition by the ignition plug 5. After combustion exhaust air is purified by the NOx adsorption catalyst 6 and three way component catalyst 7 which come to have a NOx adsorbent, it is discharged in the atmosphere through a muffler 8.

[0022] It has the function which emits NOx absorbed when the air-fuel ratio of inflow exhaust air was RIN, and the aforementioned NOx adsorption catalyst 6 absorbed NOx and became rich. The detecting signal from various sensors is inputted into the control unit 9 which built in the microcomputer which controls the fuel oil consumption by the aforementioned fuel injection valve 4. That is, the rotation signal from the crank angle sensor 11 built in the distributor 10, the water temperature signal from a coolant temperature sensor 12, the oxygen density signal from an oxygen sensor 13, the inhalation air-content signal from the air flow meter 14 as an inhalation air-content detection means, the opening signal from the throttle sensor 15, etc. are inputted into the aforementioned control unit 9.

[0023] And a control unit 9 controls the opening of ignition timing by the ignition plug 5, and the amount adjustment bulb 16 of supplementary airs while controlling the injection quantity by the aforementioned fuel injection valve 4

based on the detecting signal from the various aforementioned sensors. Here, the engine 1 of this operation gestalt is the so-called RIN combustion engine burned in the air-fuel ratio (for example, about 20 to 22 air-fuel ratio) which is RIN more sharply than theoretical air fuel ratio, and switches combustion with the aforementioned RIN air-fuel ratio, and combustion near theoretical air fuel ratio according to the routine shown in drawing 3.

[0024] It sets to the flow chart of drawing 3, and is S301. The signal of an idle switch then formed in the aforementioned throttle sensor 15 is read, and it is S302. It distinguishes whether whether an idle switch's being ON and a throttle valve 3 are in the state of a close by-pass bulb completely. And it judges that throttle-valve opening is in RIN combustion conditions when an idle switch is in the state where the throttle valve 3 is opened in OFF, and is S303. It progresses.

[0025] S303 The detecting signal according to a coolant temperature sensor 12 then is read, and it is the following S304. It distinguishes whether water temperature TW is in a predetermined temperature requirement (TWL<=TW<=TWH) then. In addition, in this example, as shown in drawing 9, the narrower range of water

temperature within the limits which performs air-fuel ratio feedback control (drawing 9 has shown "lambda KON".) which carries out feedback control of the air-fuel ratio based on the detecting signal of the aforementioned oxygen sensor 13 is made into the RIN combustion condition region.

[0026] S304 When it is distinguished that water temperature TW is a RIN combustion condition region, it progresses to S305 and the engine load TP is detected. Let basic fuel oil consumption TP of the fuel injection valve 4 computed based on the inhalation air content Q detected with the aforementioned air flow meter 14, and the engine rotational speed NE computed based on the detecting signal from the crank angle sensor 11 ($TP=Q/NExK:K$ is a constant) be a value representing an engine load in this example.

[0027] S306 It is S307, if it distinguishes whether the aforementioned engine load TP is predetermined within the limits ($TPL \leq TP \leq TPH$) then and is predetermined within the limits. It progresses and the engine rotational speed NE is detected based on the detecting signal from the crank angle sensor 11. And S308 As it distinguishes whether the engine rotational speed NE is predetermined within the limits ($NEL \leq NE \leq NEH$) then and it is shown in drawing 10, the engine load TP and the engine rotational speed NE distinguish whether it corresponds to the RIN combustion zone beforehand specified as a operating range which is predetermined within the limits, respectively.

[0028] It is S309 when it corresponds to the aforementioned RIN combustion zone. It progresses and the throttle sensor 15 detects the throttle-valve opening TVO. S310 It is S311, if it distinguishes whether the throttle-valve opening TVO is below the predetermined opening TVOH then and is below the predetermined opening TVOH. It progresses. S311 **** -- the vehicle speed VSP -- detecting -- the following S312 **** -- it distinguishes whether the vehicle speed VSP is more than the predetermined speed VSPL (refer to drawing 11)

[0029] And it is S313 if the vehicle speed VSP is more than the predetermined speed VSPL. It progresses and rate-of-change deltaVSP of the vehicle speed VSP is detected. S314 It is S315, while it distinguishes whether the aforementioned rate-of-change deltaVSP is below the predetermined value DVH (refer to drawing 11) then and the vehicle speed VSP is carrying out abbreviation stability. It progresses and 1 is set to the RIN operation permission flag FLEAN.

[0030] It is S316 when there are conditions which are not satisfied at least one of the above-mentioned conditions on the other hand. It progresses and 0 is set to the aforementioned RIN operation permission flag FLEAN. The routine shown in the flow chart of drawing 4 shows the situation of the fuel-air-ratio control based on the aforementioned RIN operation permission flag FLEAN. It sets to the flow chart of this drawing 4, and is S401 first. The aforementioned RIN operation permission flag FLEAN is distinguished.

[0031] And it is S402 when the RIN operation permission flag FLEAN is 1. It progresses and asks for the target fuel-air ratio TDML with reference to a RIN fuel-air-ratio map. On the other hand, it is S403 when the aforementioned RIN operation permission flag FLEAN is 0. It progresses and asks for the target fuel-air ratio TDML with reference to a SUTOIKI fuel-air-ratio (theoretical air fuel ratio) map.

[0032] S404 It is S405, when the aforementioned RIN operation permission flag FLEAN is then distinguished again and the RIN operation permission flag FLEAN is 1. It is the fuel-air-ratio amendment coefficient D ML spontaneously $DML = \text{Max}(DML - \Delta DML, TDML)$

It sets up by carrying out.

[0033] If the RIN operation permission flag FLEAN changes from the state of 0 to 1, it will be the change speed by the aforementioned deltaDML, and will RIN-be made for the aforementioned deltaDML to be the step variation of the fuel-air-ratio amendment coefficient D ML to which the time when opening rate-of-change deltaTVO of a throttle valve is larger is set as a big value, and to beized as shown in drawing 12 by the target fuel-air ratio TDML gradually.

[0034] On the other hand, it is S406 when the RIN operation permission flag FLEAN is 0. It is the fuel-air-ratio amendment coefficient D ML spontaneously $DML = \text{Min}(DML + \Delta DML, TDML)$

It sets up by carrying out. That is, when switching to SUTOIKI (theoretical air fuel ratio) from a RIN combustion state, it is made to turn into the target fuel-air ratio TDML richly gradually at the change speed by the aforementioned deltaDML (refer to drawing 12).

[0035] S407 **** -- the aforementioned fuel-air-ratio amendment coefficient D ML -- 1.0 it is -- a ***** -- distinguishing -- the aforementioned fuel-air-ratio amendment coefficient D ML -- 1.0 it is -- when making combustion by theoretical air fuel ratio perform, this routine is terminated as it is on the other hand -- S407 the aforementioned fuel-air-ratio amendment coefficient D ML -- 1.0 it is not -- if -- since air-fuel ratio feedback control which brings an actual air-fuel ratio close to theoretical air fuel ratio is not performed when distinguished -- S408 progressing -- air-fuel ratio feedback amendment coefficient A LPHA -- 1.0 It clamps.

[0036] The routine shown in the flow chart of drawing 5 computes the NOx amount of adsorption in the aforementioned NOx adsorption catalyst 6. In addition, the function shown in the flow chart of this drawing 5 is equivalent to a NOx amount-of-adsorption calculation means. S501 The aforementioned fuel-air-ratio amendment coefficient D ML is 1.0. Based on whether it is the following, it distinguishes whether it is in a RIN combustion state.

[0037] The fuel-air-ratio amendment coefficient D ML is 1.0. Since the aforementioned NOx adsorption catalyst 6 will be adsorbed in NOx when it is the following and RIN combustion is carried out, it is S502. It progresses and the NOx rate of adsorption DABSR is presumed based on a lower formula.

$DABSR = DABSR0 \# \times TP / TP0 \times Q / Q0 \times (ABSFC\# - ABSTC) / ABSFC\#$ -- here, DABSR0# is the amount of adsorption [in / this time / a criteria air content and ABSFC#, and], a criteria rate of adsorption and TP0 presume a rate of adsorption DABSR greatly, so that the inhalation air content Q is so large that a load TP is large, and further, they have considered it as the composition which presumes a rate of adsorption DABSR late, so that the amount of adsorption ABSTC of 0 increases / the maximum amount of adsorption

[0038] The following S503 The NOx amount of adsorption ABSTC at present is presumed according to a lower formula, using the aforementioned rate of adsorption DABSR then.

$ABSTC = ABSTC(\text{old}) + DABSR$ one side and S501 The fuel-air-ratio amendment coefficient D ML is 1.0. Since it is at the theoretical-air-fuel-ratio combustion time and NOx by which the aforementioned NOx adsorption catalyst 6 was adsorbed will be emitted when it was not the following and is distinguished, it is S504. The NOx desorption rate DPRGR is presumed according to a lower formula.

[0039] $DPRGR = DPRGR0 \# \times TP / TP0 \times Q / Q0 \times ABSTC / ABSFC\#$ -- here, aforementioned DPRGR0# is the desorption rate of criteria S505 The NOx amount of adsorption ABSTC at present is presumed according to a lower formula, using the aforementioned desorption rate DPRGR then.

[0040] The routine shown in the flow chart of $ABSTC = ABSTC(\text{old}) - DPRGR$ drawing 6 shows air-fuel ratio feedback control, and is performed for every rotation of an engine. In addition, the function shown in the flow chart of this drawing 6 is equivalent to an air-fuel ratio feedback control means, a rich-ized means, and rich-ized degree control means.

[0041] S601 The aforementioned fuel-air-ratio amendment coefficient D ML is 1.0. Based on whether it is the following, it distinguishes whether it is in a RIN combustion state. It is S610 when it is at the RIN combustion time. 1 is set to the rich-ized execution flag FRSFT, and it is S611. It is air-fuel ratio feedback amendment coefficient A LPHA 1.0 It clamps and this routine is terminated.

[0042] on the other hand -- the aforementioned fuel-air-ratio amendment coefficient D ML -- 1.0 it is -- the time of being at the theoretical-air-fuel-ratio combustion time -- S602 the time of predetermined clamp conditions being satisfied, even if it progresses, it distinguishes whether predetermined clamp conditions are satisfied and it is at the theoretical-air-fuel-ratio combustion time -- S611 progressing -- air-fuel ratio feedback amendment coefficient A LPHA -- 1.0 It clamps and this routine is terminated.

[0043] It is S603 when clamp conditions are not satisfied. It progresses and distinguishes whether 1 is set to the aforementioned rich-ized execution flag FRSFT. It is S612 when the aforementioned rich-ized execution flag FRSFT is 0. It progresses and asks for the integration part i used for the proportional-plus-integral control of the aforementioned air-fuel ratio feedback amendment coefficient A LPHA, and parts PR and PL (refer to drawing 13) been proportional with reference to a map, respectively.

[0044] S609 [and] rich RIN of an actual air-fuel ratio to the theoretical air fuel ratio which progresses and is detected by the oxygen sensor 13 -- being based -- the proportional-plus-integral control of air-fuel ratio feedback amendment coefficient A LPHA -- it carries out On the other hand, it is S603. It is S604 when it is distinguished that the rich-ized execution flag FRSFT is 1. It progresses and the rich-ized degree LRPL is set up according to the NOx amount of adsorption ABSTC. Here, since the amount of HC which needs the time with more NOx amount of adsorption to return when this ****s increases, the time with much NOx amount of adsorption has set up the rich-ized degree LRPL greatly.

[0045] the following S605 **** -- according to the engine load TP and rotational speed NE, the rich-ized degree study correction factor LRPLHS is referred to from a map. Although later mentioned about a study setup of the aforementioned rich-ized degree study correction factor LRPLHS, it is learned based on the detection result of the concentration of NOx by the NOx concentration sensor 17 as a NOx concentration detection means prepared in the downstream of the NOx adsorption catalyst 6 and a three way component catalyst 7.

[0046] S606 While setting up as $PL=LRPLxLRPLHS$ the proportionality part PL (refer to drawing 13) used for an increase setup according then to the proportional control of air-fuel ratio feedback amendment coefficient A LPHA, PR used for reduction proportional control are set to 0. Furthermore, predetermined value LRI# is set as an integration part i used for the integral control of amendment coefficient A LPHA.

[0047] By carrying out an increase setup, the proportionality part PL (proportionality control input) used for an increase setup by the proportional control of amendment coefficient A LPHA as mentioned above RIN -> it is [whether only one period of feedback of rich-izing which makes an air-fuel ratio rich temporarily and starts at the time of a SUTOIKI switch was performed, and] S607. If it distinguishes and only a period is made rich 1 round S608 0 is spontaneously set to the aforementioned rich-ized execution flag FRSFT, and the usual feedback control is made to be performed after that.

[0048] The routine shown in the flow chart of drawing 7 shows the situation of study of the aforementioned rich-ized degree study correction factor LRPLHS, and after [the rich shift end based on the flow chart of aforementioned drawing 6 (i.e., when the rich-ized execution flag FRSFT is switched to 0 from 1)], it has been made to perform each time. In addition, the function shown in the flow chart of this drawing 7 is also equivalent to rich-ized degree control means.

[0049] S701 Service conditions, such as the engine load TP and rotational speed NE, are detected. S702 It is then based on the NOx amount of adsorption ABSTC and the inhalation air content Q, and the desired value SLTNOX of the NOx discharge at the time of a RIN -> SUTOIKI switch is calculated. S703 **** -- the actual NOx discharge TALNOX at the time of the RIN -> SUTOIKI switch for which it asked according to the flow chart of drawing 8 mentioned later distinguishes whether it is below the value that subtracted predetermined value HYSNOX# from the aforementioned desired value SLTNOX

[0050] It is S704 when the actual NOx discharge TALNOX is much less than the aforementioned desired value SLTNOX. It progresses and the rich-ized degree study correction factor LRPLHS is referred to from the applicable field of a map. S705 [and] **** -- the aforementioned correction factor LRPLHS -- predetermined value DPL# -- reduction amendment -- carrying out -- the following S706 **** -- map data are rewritten to the correction factor LRPLHS after this reduction amendment

[0051] That is, since a NOx discharge may be able to be suppressed below at a target even if it decreases a rich-ized degree when the NOx discharge is much less than the target, a correction factor LRPLHS is decreased that a superfluous rich shift should be avoided. On the other hand, it is S703. It is S707, when the actual NOx discharge TALNOX was over the value which subtracted predetermined value HYSNOX# from the aforementioned desired value SLTNOX and it is distinguished. It progresses and distinguishes whether it is beyond the value to which the actual NOx discharge TALNOX added predetermined value HYSNOX# to the aforementioned desired value SLTNOX.

[0052] and -- the case where it is beyond the value to which the actual NOx discharge TALNOX added predetermined value HYSNOX# to the aforementioned desired value SLTNOX -- S708 progressing -- the correction factor LRPLHS of a map to the present condition -- reading -- S709 **** -- the read correction factor LRPLHS -- predetermined value DPL# -- increase amendment -- carrying out -- S710 **** -- map data are updated based on the correction factor LRPLHS which carried out [aforementioned] increase amendment

[0053] That is, when the actual NOx discharge TALNOX far exceeds desired value, there are few rich-ized degrees, and since what is insufficient of the amounts of HC needed for purification of NOx is presumed, it is an increase amendment thing about the aforementioned correction factor LRPLHS that a rich-ized degree should be enlarged and the amount of HC should be increased. On the other hand, when the actual NOx discharge TALNOX is within the limits of desired value SLTNOX**HYSNOX#, it judges that the present rich shift amount is proper, and this routine is ended, without updating map data.

[0054] The routine shown in the flow chart of drawing 8 is a routine for calculating the aforementioned NOx discharge TALNOX, and the function shown in this flow chart is equivalent to a NOx discharge calculation means. S801 The aforementioned fuel-air-ratio amendment coefficient D ML is 1.0. Based on whether it is above, it distinguishes whether it is in a SUTOIKI combustion state.

[0055] The aforementioned fuel-air-ratio amendment coefficient D ML is 1.0. It is S802, when it is above and is at the SUTOIKI combustion time. It progresses and the desired value QR of an accumulation air content is set up based on

the aforementioned NOx amount of adsorption ABSTC. That is, the total amount of the NOx discharge discharged by the time the accumulation value QSUM of the actual inhalation air content after a RIN -> SUTOIKI switch reached the aforementioned desired value QR is calculated, and the time with much NOx amount of adsorption ABSTC sets up the aforementioned desired value QR greatly.

[0056] S803 It is S804, when it distinguishes whether the accumulation QSUM of the inhalation air content after a RIN -> SUTOIKI switch became then beyond the aforementioned desired value QR and desired value QR is not reached. It progresses. S804 The NOx concentration CNCNOX in the catalyst 6 and seven downstreams (catalyst outlet) which were then detected by the aforementioned NOx concentration sensor 17 is read.

[0057] S805 The inhalation air content Q then detected with the air flow meter 14 is read. S806 The NOx discharge TALNOX is calculated then according to a lower formula.

TALNOX=TALNOX+QxCNCNOXS807 The accumulation air content QSUM is calculated then according to a lower formula.

QSUM=QSUM+Q one side and the aforementioned fuel-air-ratio amendment coefficient D ML are 1.0. At the time of the RIN combustion distinguished as it is the following, it is S808. It progresses, the zero reset of the aforementioned accumulation air content QSUM and the NOx discharge TALNOX is carried out, respectively, and the accumulation air content QSUM after a RIN -> SUTOIKI switch and the NOx discharge TALNOX are calculated (refer to drawing 14).

[0058]

[Effect of the Invention] As explained above, when NOx is desorbed from a NOx adsorption catalyst according to invention according to claim 1 In the composition which aims at reservation of the amount of HC which turns an air-fuel ratio richly temporarily and is needed for reduction processing of NOx Since the degree of the aforementioned rich-izing is controlled based on NOx concentration, a rich degree is controlled proper and it is effective in increase of the amount of HC by superfluous rich-izing and increase of the amount of NOx(es) by too little rich-izing being certainly avoidable.

[0059] According to invention according to claim 2, even if a service condition changes, it is effective in it being avoidable that perform proper rich-ized control in each service condition, and can control NOx concentration low stably, and the amount of HC increases by superfluous rich-ization. It is effective in superfluous rich-ization being avoidable, avoiding that a NOx discharge comes to exceed an allowed value according to invention according to claim 3, since a NOx discharge is calculated from NOx concentration.

[0060] According to invention according to claim 4, it is effective in it becoming possible to be able to perform control corresponding to permission of a different NOx discharge according to the NOx amount of adsorption, and to make it control by the rich-ized degree comparatively near proper level beforehand with a NOx discharge according to the NOx amount of adsorption, since the NOx amount of adsorption is calculated. According to invention according to claim 5, it is effective in the total amount of the NOx discharge permitted based on the total amount and inhalation air content of the NOx amount of adsorption being set up as desired value, and being able to set up a proper rich-ized degree whose actual NOx discharge corresponds with this desired value.

[0061] According to invention according to claim 6, even if it is before correcting a rich-ized degree with high precision based on the total amount of a NOx discharge since the basic value of a rich-ized degree is set up based on the total amount of the NOx amount of adsorption, it is effective in it being avoidable that NOx will be discharged so much. According to invention according to claim 7, it is effective in the ability to calculate the total amount of NOx from which the NOx adsorption catalyst is adsorbed and it was desorbed with a sufficient precision.

[0062] According to invention according to claim 8, in order to return NOx from which it was desorbed, even if it changes an air-fuel ratio into a rich state temporarily, there is an effect of the ability to make it change to the state near a target air-fuel ratio smoothly after that.

[Translation done.]

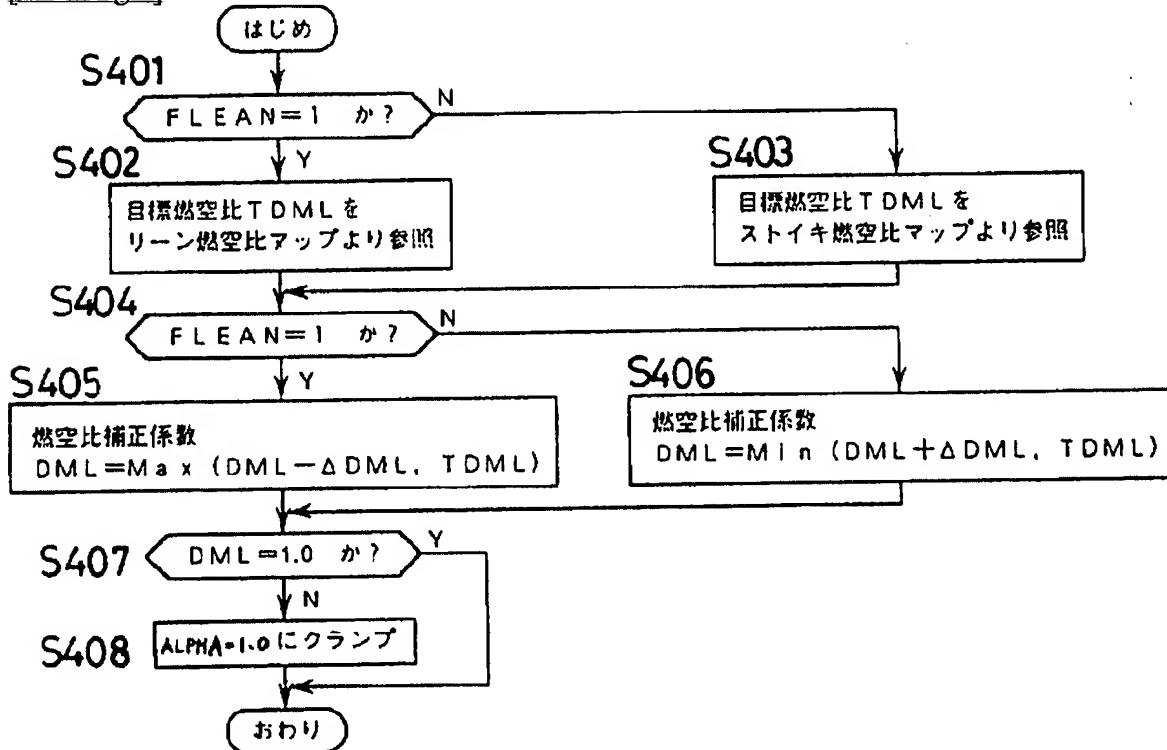
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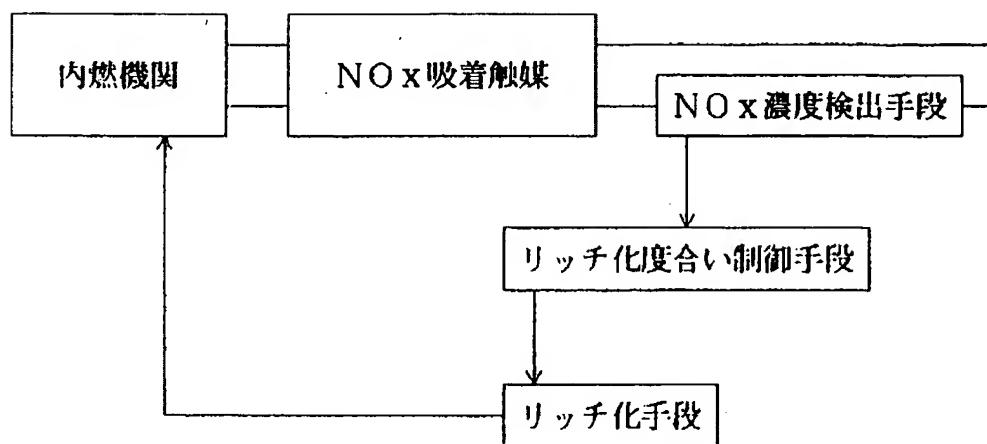
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2. *** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DRAWINGS

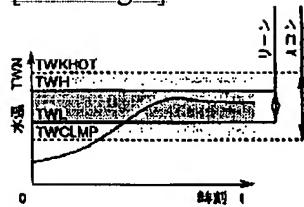
[Drawing 4]



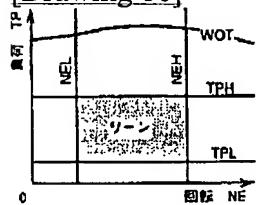
[Drawing 1]



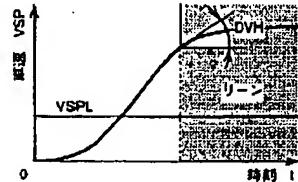
[Drawing 9]



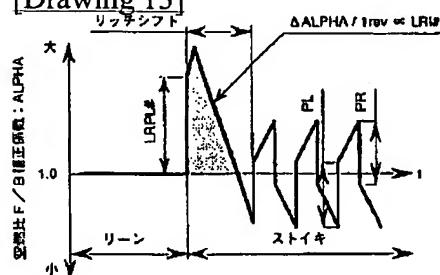
[Drawing 10]



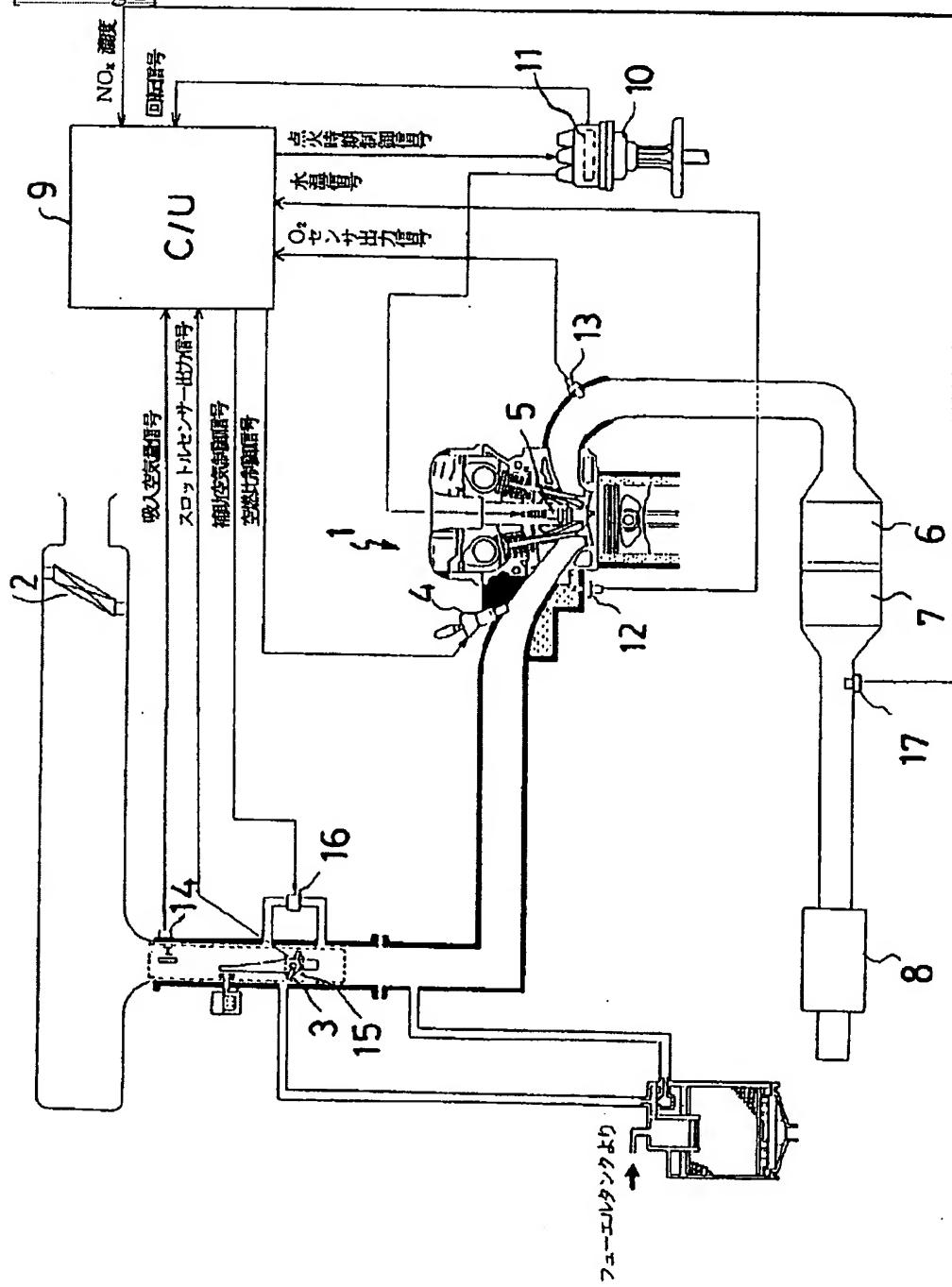
[Drawing 11]



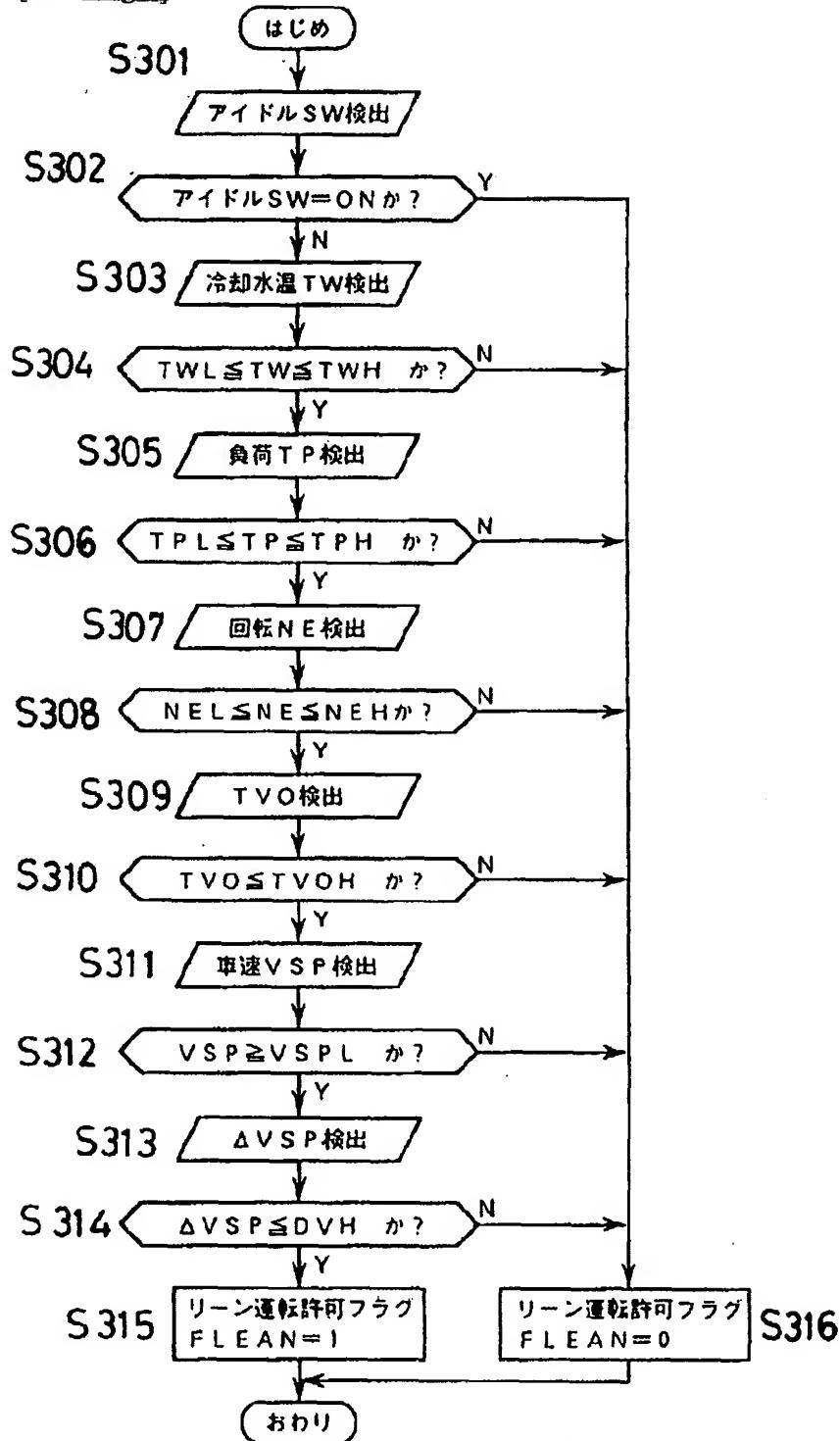
[Drawing 13]



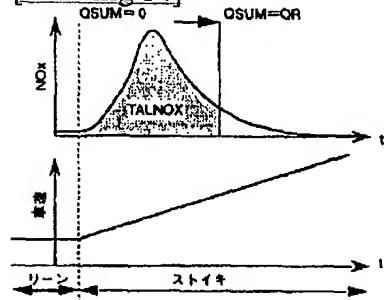
[Drawing 2]



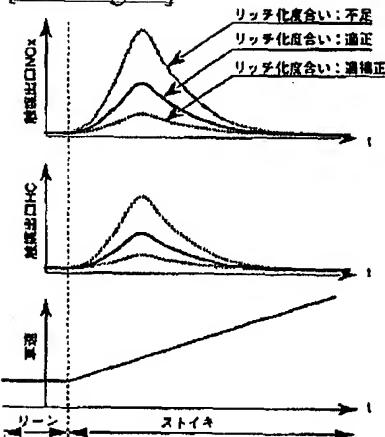
[Drawing 3]



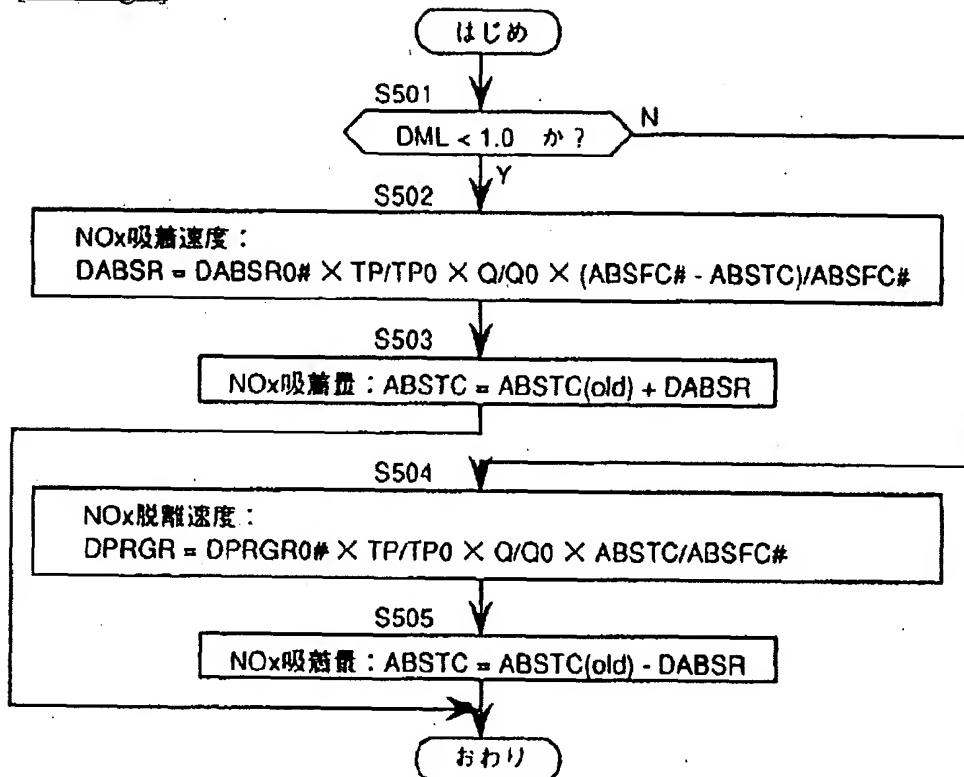
[Drawing 14]



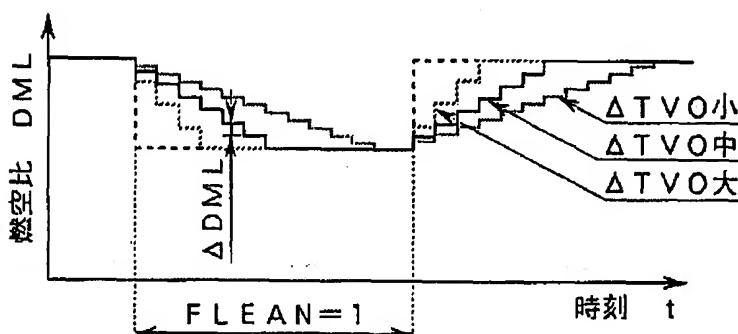
[Drawing 15]



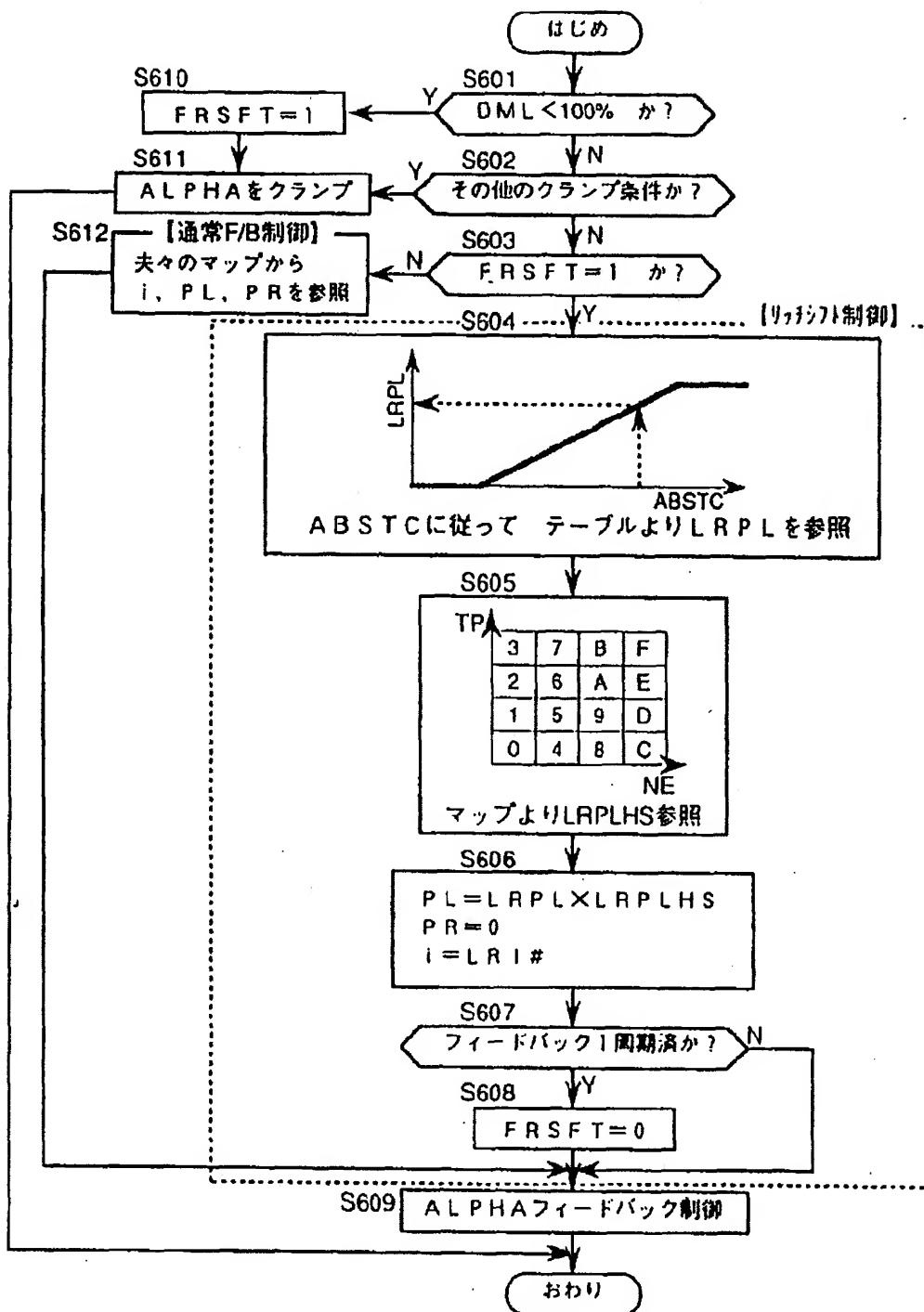
[Drawing 5]



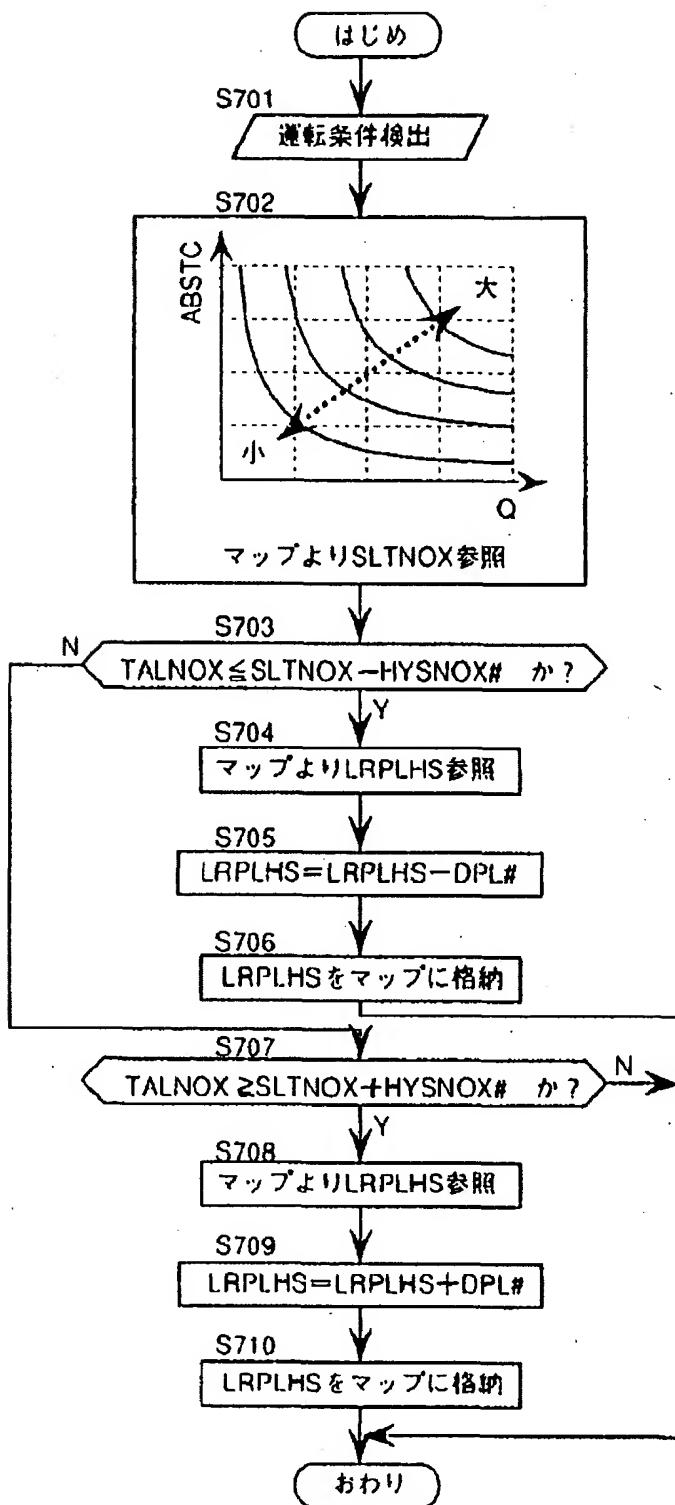
[Drawing 12]



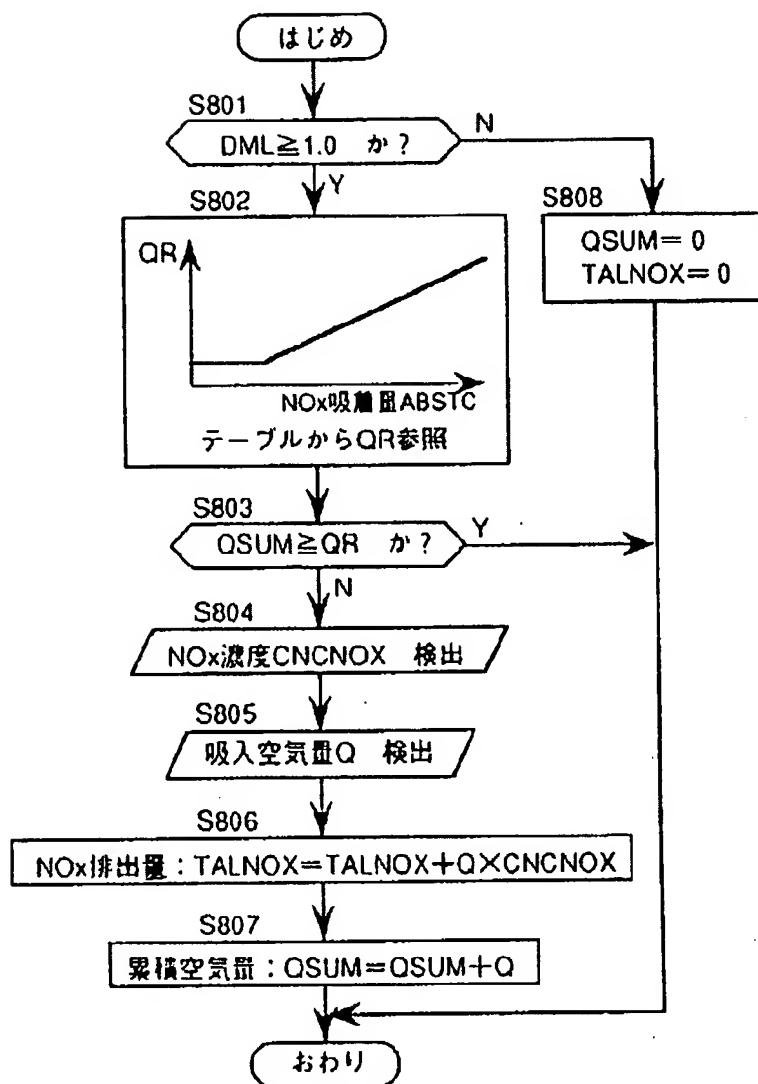
[Drawing 6]



[Drawing 7]



[Drawing 8]



[Translation done.]

(19)



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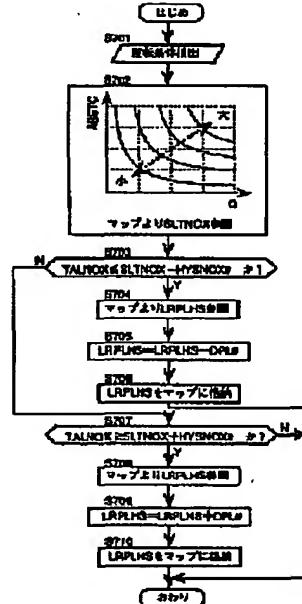
(54) AIR-FUEL RATIO CONTROL DEVICE OF INTERNAL COMBUSTION ENGINE

(57) Abstract:

PROBLEM TO BE SOLVED: To deoxidize NOx desorbed from a NOx adsorption catalyst by making the NOx properly rich corresponding to the desorption quantity of NOx at the time of transition from the lean burn to stoichiometric burn.

SOLUTION: The target SLTNOX of NOx quantity discharged at the time of transition from lean burn to stoichiometric burn is set according to the NOx adsorption quantity ABSTC and intake air quantity Q during lean combustion (S702). The target SLTNOX is compared with the actual NOx discharge quantity TALNOX (S703, S707) and rich degree LRPLHS is learned in such manner that the actual NOx discharge quantity TALNOX is restrained within the range of the target SLTNOX \pm designated value HYSNOX# (S704-S706, S708-S710).

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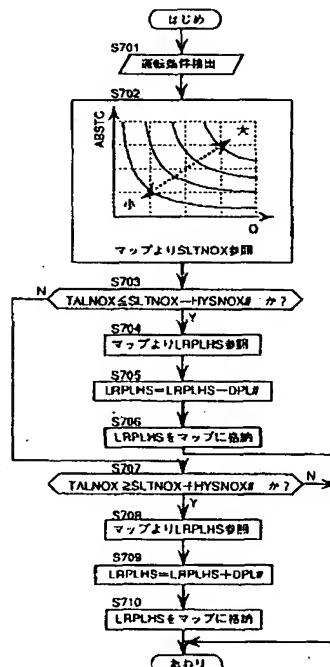
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(54)【発明の名称】 内燃機関の空燃比制御装置

(57)【要約】

【課題】リーン燃焼からストイキ燃焼に移行したときに、NO_x吸着触媒から脱離されるNO_xを、NO_xの脱離量に見合った適正なリッチ化により良好に還元処理する。

【解決手段】リーン燃焼からストイキ燃焼に移行したときに排出されるNO_x量の目標SLTNOXを、リーン燃焼中のNO_x吸着量ABSTCと吸入空気量Qとに基づいて設定する(S702)。そして、前記目標SLTNOXと、実際のNO_x排出量TALNOXとを比較し(S703, S707)、目標SLTNOX±所定値HYSNOX#の範囲内に実際のNO_x排出量TALNOXが抑制されるように、リッチ化度合いLRPLHSを学習する(S704～S706, S708～S710)。



【特許請求の範囲】

【請求項1】理論空燃比よりもリーン空燃比雰囲気において排気中のNO_xを吸着し、理論空燃比以下の空燃比雰囲気において前記吸着じたNO_xを脱離するNO_x吸着触媒を排気通路に備えてなる内燃機関の空燃比制御装置であつて、前記リーン空燃比で燃焼させる運転領域から理論空燃比付近で燃焼させる運転領域に移行したときに一時的に空燃比を目標空燃比よりもリッチ化させるリッチ化手段と、前記NO_x吸着触媒の下流側において排気中のNO_x濃度を検出するNO_x濃度検出手段と、該NO_x濃度検出手段で検出された排気中のNO_x濃度に応じて前記リッチ化手段によるリッチ化度合いを制御するリッチ化度合い制御手段と、を備えたことを特徴とする内燃機関の空燃比制御装置。

【請求項2】前記リッチ化度合い制御手段が、機関負荷と機関回転速度とによって複数に区分される運転領域毎に、NO_x濃度の検出値に基づき制御したリッチ化度合いを学習することを特徴とする請求項1記載の内燃機関の空燃比制御装置。

【請求項3】前記リッチ化度合い制御手段が、機関の吸入空気量を検出する吸入空気量検出手段と、該吸入空気量検出手段で検出された吸入空気量と、前記NO_x濃度検出手段で検出された排気中のNO_x濃度とに基づいて、前記リーン空燃比で燃焼させる運転領域から理論空燃比付近で燃焼させる運転領域に移行した直後の所定期間におけるNO_x排出量の総量を算出するNO_x排出量算出手段と、を含んで構成され、該NO_x排出量算出手段で算出されたNO_x排出量の総量に基づいて前記リッチ化手段によるリッチ化度合いを制御することを特徴とする請求項1又は2に記載の内燃機関の空燃比制御装置。

【請求項4】前記リーン空燃比で燃焼させる運転領域において、前記NO_x吸着触媒に吸着されたNO_x吸着量の総量を算出するNO_x吸着量算出手段を備え、前記リッチ化度合い制御手段が、前記NO_x吸着量算出手段で算出されたNO_x吸着量の総量と、前記NO_x排出量算出手段で算出されたNO_x排出量の総量に基づいて前記リッチ化手段によるリッチ化度合いを制御することを特徴とする請求項3記載の内燃機関の空燃比制御装置。

【請求項5】前記リッチ化度合い制御手段が、前記NO_x吸着量算出手段で算出されたNO_x吸着量の総量と吸入空気量とに基づいて設定したNO_x排出量の総量の目標値に、前記NO_x排出量算出手段で算出されたNO_x排出量の総量が近づくように、前記リッチ化手段によるリッチ化度合いを制御することを特徴とする請求項4記載の内燃機関の空燃比制御装置。

【請求項6】前記リッチ化度合い制御手段が、前記NO_x

吸着量算出手段で算出されたNO_x吸着量の総量に基づく基本リッチ化度合いを、前記NO_x排出量算出手段で算出されたNO_x排出量の総量に基づいて修正することを特徴とする請求項4又は5に記載の内燃機関の空燃比制御装置。

【請求項7】前記NO_x排出量算出手段が、前記NO_x吸着量算出手段で算出されたNO_x吸着量に基づいて設定した吸入空気量の積算目標値に実際の吸入空気量の積算値が達するまでの期間を、前記NO_x排出量の総量を算出する所定期間とすることを特徴とする請求項4～6のいずれか1つに記載の内燃機関の空燃比制御装置。

【請求項8】理論空燃比付近で燃焼させる運転領域において、目標空燃比に実際の空燃比を近づけるように機関吸入混合気の空燃比を少なくとも比例・積分制御によって制御する空燃比フィードバック制御手段を備え、前記リッチ化手段が、前記空燃比フィードバック制御手段におけるリッチ化方向の比例操作量を増大補正することで、一時的に空燃比を目標空燃比よりもリッチ化させる構成であり、かつ、前記空燃比フィードバック制御手段による1制御周期が終了した時点で前記比例操作量の増大補正を中止することを特徴とする請求項1～7のいずれか1つに記載の内燃機関の空燃比制御装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は内燃機関の空燃比制御装置に関し、詳しくは、機関排気通路にNO_xを吸着するNO_x吸着触媒を有し、該NO_x吸着触媒に吸着されたNO_xを理論空燃比以下の燃焼状態でHC、COと反応させて浄化するシステムにおいて、前記NO_x浄化を適正に行わせるための空燃比制御技術に関する。

【0002】

【従来の技術】従来、前記NO_x吸着触媒を備えた内燃機関としては、特開平6-129246号公報に開示されるようなものがあった。このものは、流入排気の空燃比がリーンであるときにNO_xを吸収し、リッチになると吸収したNO_xを放出するNO_x吸着剤を排気通路に備え、リーン運転から理論空燃比付近での運転に移行するときに、空燃比を一時的にリッチにした後に理論空燃比付近にする構成であり、前記リッチ化度合い或いはリッチ化の期間を、NO_x吸着剤に蓄えられたNO_x量に基づいて制御する構成となっている。

【0003】かかる構成によると、リーン運転から理論空燃比付近での運転への移行に伴って放出されるNO_x量に見合うだけのHCを確保することができ、以て、NO_xを良好に浄化できる。

【0004】

【発明が解決しようとする課題】しかしながら、上記従来の装置では、前記リッチ化度合いが適正であるか否かを判定する手段をもたない構成であったため、リッチ化によるNO_x低減効果が要求通りに発揮されなかつた

り、リッチ化度合いが過剰となって排気性状や燃費を悪化させる惧れがあった。

【0005】即ち、リッチ化制御に見合ったリッチ空燃比に制御されない場合や、NO_x吸着剤のばらつき等によって予測されるNO_x量とは異なるNO_x量が放出される場合には、NO_x吸着剤に蓄えられたNO_x量に基づいてリッチ化度合いを制御しても、かかるリッチ化度合いが適正量とはならず、リッチ化が過剰であるとHC排出量が増大し、また、燃費を悪化させることになり、逆に、リッチ化が過小であると、NO_xの浄化性能が低下してNO_x排出量を要求レベル以下に抑制することができなくなってしまう(図15参照)。

【0006】リッチ化制御に見合ったリッチ空燃比に制御されない場合とは、例えば製品の特性ばらつき等によって、ベースとなる空燃比が元々リーン側になっていて、リッチ化を行っても所望の値よりもリーンになり、充分なHCの供給が行えない場合、逆に、ベース空燃比がリッチ側になっていて、所望よりもリッチ化され、余剰のHCが排出される場合である。ここで、前記ベース空燃比のばらつきを解消する技術として空燃比学習制御が知られているが、リーン運転から理論空燃比運転に移行する典型的なパターンである加速状態への移行時には、吸入空気量の計測誤差が生じ易く、また、吸気ポート壁面に付着している燃料の状態も大きく変化するから、定常時の空燃比安定を狙いとする前記空燃比学習では、リーン運転から理論空燃比運転に移行するときのベース空燃比を高精度に補正できず、結果的に、リッチ化制御によって所期のリッチ混合気を形成することができない場合が生じる。

【0007】また、NO_x吸着剤の吸着能力や放出作用にもばらつきがあるから、吸着量の推定に誤りが生じる可能性があり、また、吸着量の推定に誤りがない場合であっても、その放出量にばらつきが発生する可能性があり、NO_x量に精度良く対応したリッチ化度合いに制御することが困難であった。尚、前記従来装置には、NO_x吸着剤の下流側でのHC濃度を検出して、NO_x放出作用の完了を検出し、以て、リッチ化を終了させる構成の開示があるが、この場合も、NO_x放出作用終了後の無用なリッチ化によってHC量が所定量を越える状態を検出するものであるから、NO_x放出中のリッチ化度合いを最適に制御できるものではなく、結果的に、過剰なリッチ化による燃費・排気性状の悪化を招く惧れがある。

【0008】本発明は上記問題点に鑑みなされたものであり、ベース空燃比のばらつきやNO_x吸着剤のばらつきがあっても、NO_xの低減に最適なリッチ化制御を安定的に行えるようにし、以て、NO_x排出量を確実に抑制しつつ、HC量の増大や燃費の悪化を回避できるようにすることを目的とする。

【0009】

【課題を解決するための手段】そのため請求項1記載の発明は、図1に示すように構成される。図1において、NO_x吸着触媒は、理論空燃比よりもリーン空燃比雰囲気において排気中のNO_xを吸着し、理論空燃比以下の空燃比雰囲気において前記吸着したNO_xを脱離する触媒であって排気通路に備えられる。

【0010】リッチ化手段は、前記リーン空燃比で燃焼させる運転領域から理論空燃比付近で燃焼させる運転領域に移行したときに一時的に空燃比を目標空燃比よりもリッチ化させる。一方、NO_x濃度検出手段は、前記NO_x吸着触媒の下流側において排気中のNO_x濃度を検出する。

【0011】そして、リッチ化度合い制御手段は、NO_x濃度検出手段で検出された排気中のNO_x濃度に応じて前記リッチ化手段によるリッチ化度合いを制御する。かかる構成によると、前記リーン空燃比で燃焼させる運転領域から理論空燃比付近で燃焼させる運転領域に移行し、NO_x吸着触媒からNO_xが脱離されるときに、空燃比を積極的にリッチ化して、NO_xの還元処理に必要とされるHC量の確保を図る。ここで、リッチ化度合いが過小であると、NO_xを良好に還元できずにNO_x濃度が大きくなる一方、リッチ化度合いが過大であると、NO_x濃度は大きく低下するもののHC濃度が増大するので、NO_x濃度を監視して、前記リッチ化度合いが適正となるように制御する構成とした。

【0012】請求項2記載の発明では、前記リッチ化度合い制御手段が、機関負荷と機関回転速度とによって複数に区分される運転領域毎に、NO_x濃度の検出値に基づき制御したリッチ化度合いを学習する構成とした。かかる構成によると、機関負荷と機関回転速度とによって複数に区分される運転領域毎に、NO_x濃度を適正值にできるリッチ化度合いが学習されるから、運転条件が異なっても、安定的にNO_x濃度を低く制御でき、また、過剰なリッチ化によってHC量が増大することを回避できる。

【0013】請求項3記載の発明では、前記リッチ化度合い制御手段が、機関の吸入空気量を検出する吸入空気量検出手段と、該吸入空気量検出手段で検出された吸入空気量と、前記NO_x濃度検出手段で検出された排気中のNO_x濃度等に基づいて、前記リーン空燃比で燃焼させる運転領域から理論空燃比付近で燃焼させる運転領域に移行した直後の所定期間におけるNO_x排出量の総量を算出するNO_x排出量算出手段と、を含んで構成され、該NO_x排出量算出手段で算出されたNO_x排出量の総量に基づいて前記リッチ化手段によるリッチ化度合いを制御する構成とした。

【0014】かかる構成によると、NO_x排出量が許容値を越えるようになることを回避しつつ、過剰なリッチ化を回避できることになる。請求項4記載の発明では、前記リーン空燃比で燃焼させる運転領域において、前記

NO_x吸着触媒に吸着されたNO_x吸着量の総量を算出するNO_x吸着量算出手段を備え、前記リッチ化度合い制御手段が、前記NO_x吸着量算出手段で算出されたNO_x吸着量の総量と、前記NO_x排出量算出手段で算出されたNO_x排出量の総量に基づいて前記リッチ化手段によるリッチ化度合いを制御する構成とした。

【0015】かかる構成によると、例えばNO_x吸着量の総量に応じて許容されるNO_x排出量が異なる場合に、かかる要求に対応した適切なリッチ化度合いに制御することが可能となり、また、NO_x吸着量に応じて異なるリッチ化度合いの要求に予め対応した制御が可能となる。請求項5記載の発明では、前記リッチ化度合い制御手段が、前記NO_x吸着量算出手段で算出されたNO_x吸着量の総量と吸入空気量に基づいて設定したNO_x排出量の総量の目標値に、前記NO_x排出量算出手段で算出されたNO_x排出量の総量が近づくように、前記リッチ化手段によるリッチ化度合いを制御する構成とした。

【0016】かかる構成によると、NO_x吸着量の総量と吸入空気量に基づいて許容されるNO_x排出量の総量が目標値として設定され、実際の排出量がかかる目標値となる適正なリッチ化が行われることになる。請求項6記載の発明では、前記リッチ化度合い制御手段が、前記NO_x吸着量算出手段で算出されたNO_x吸着量の総量に基づく基本リッチ化度合いを、前記NO_x排出量算出手段で算出されたNO_x排出量の総量に基づいて修正する構成とした。

【0017】かかる構成によると、基本的には、NO_x吸着量が多いときほどリッチ化度合いを大きくする必要があるので、NO_x排出量の総量に基づく修正が行われる前であっても、少なくとも吸着量に見合ったリッチ化度合いに制御できる。請求項7記載の発明では、前記NO_x排出量算出手段が、前記NO_x吸着量算出手段で算出されたNO_x吸着量に基づいて設定した吸入空気量の積算目標値に実際の吸入空気量の積算値が達するまでの期間を、前記NO_x排出量の総量を算出する所定期間とする構成とした。

【0018】かかる構成によると、NO_x吸着量が多いときほど、吸着されたNO_xの脱離に長い期間を要することになるから、NO_x吸着量に基づいて設定した目標値に実際の吸入空気量の積算値が到達するまでを、NO_x排出量の総量を求める期間として設定し、脱離されたNO_xの総量を精度良く求められる。請求項8記載の発明では、理論空燃比付近で燃焼させる運転領域において、目標空燃比に実際の空燃比を近づけるように機関吸入混合気の空燃比を少なくとも比例・積分制御によって制御する空燃比フィードバック制御手段を備え、前記リッチ化手段が、前記空燃比フィードバック制御手段におけるリッチ化方向の比例操作量を増大補正することで、一時的に空燃比を目標空燃比よりもリッチ化させる構成

であり、かつ、前記空燃比フィードバック制御手段による1制御周期が終了した時点で前記比例操作量の増大補正を中止する構成とした。

【0019】かかる構成によると、比例操作量の増大補正によって一時的にリッチ化された空燃比が徐々に目標空燃比付近に復帰し、再度リッチ化方向に比例制御が行われる段階、即ち、1制御周期を終了した時点では、比例操作量の増大補正が中止されるので、リッチ化制御状態から目標空燃比付近の状態へと滑らかに変化させることができる。

【0020】

【発明の実施の形態】以下に本発明の実施の形態を説明する。図2は、本実施形態における内燃機関のシステム構成を示す図である。この図2において、内燃機関1には、エアクリーナ2を介した空気がスロットル弁3で流量調整されて吸引される。

【0021】各気筒の吸気ポートに介装された燃料噴射弁4から噴射供給される燃料が前記空気と混合して混合気が形成され、シリンダ内に吸引された混合気を、点火栓5による火花点火で着火燃焼させる。燃焼排気は、NO_x吸着剤を有してなるNO_x吸着触媒6及び三元触媒7で浄化された後、マフラー8を介して大気中に排出される。

【0022】前記NO_x吸着触媒6は、流入排気の空燃比がリーンであるときにNO_xを吸収し、リッチになると吸収したNO_xを放出する機能を有するものである。前記燃料噴射弁4による燃料噴射量を制御するマイクロコンピュータを内蔵したコントロールユニット9には、各種センサからの検出信号が入力される。即ち、前記コントロールユニット9には、ディストリビュータ10に内蔵されたクランク角センサ11からの回転信号、水温センサ12からの水温信号、酸素センサ13からの酸素濃度信号、吸入空気量検出手段としてのエアフローメータ14からの吸入空気量信号、スロットルセンサ15からの開度信号等が入力される。

【0023】そして、コントロールユニット9は前記各種センサからの検出信号に基づいて前記燃料噴射弁4による噴射量を制御すると共に、点火栓5による点火時期、補助空気量調整バルブ16の開度を制御する。ここで、本実施形態の機関1は、理論空燃比よりも大幅にリーンである空燃比（例えば空燃比20~22程度）で燃焼させる所謂リーン燃焼機関であり、図3に示すルーチンに従って、前記リーン空燃比での燃焼と、理論空燃比付近での燃焼とを切り換えるようになっている。

【0024】図3のフローチャートにおいて、S301では、前記スロットルセンサ15に設けられたアイドルスイッチの信号を読み込み、S302で、アイドルスイッチがONであるか否か、即ち、スロットル弁3が全閉の状態であるか否かを判別する。そして、アイドルスイッチがOFFでスロットル弁3が開かれている状態であるとき

には、スロットル弁開度がリーン燃焼条件にあると判断してS303へ進む。

【0025】S303では、水温センサ12による検出信号を読み込み、次のS304では、水温TWが所定温度範囲内($TWL \leq TW \leq TWH$)であるか否かを判別する。尚、本実施例では、図9に示すように、前記酸素センサ13の検出信号に基づいて空燃比をフィードバック制御する空燃比フィードバック制御(図9では、「入コン」と示してある。)を実行する水温範囲内のより狭い範囲をリーン燃焼条件域としてある。

【0026】S304で、水温TWがリーン燃焼条件域であると判別された場合には、S305へ進み、機関負荷TPの検出を行う。本実施例では、前記エアフローメータ14で検出される吸入空気量Qと、クランク角センサ11からの検出信号に基づいて算出される機関回転速度NEとに基づいて算出される燃料噴射弁4の基本燃料噴射量TP($TP = Q / NE \times K$:Kは定数)を、機関負荷を代表する値とする。

【0027】S306では、前記機関負荷TPが所定範囲内($TPL \leq TP \leq TPH$)であるか否かを判別し、所定範囲内であれば、S307へ進んで、クランク角センサ11からの検出信号に基づいて機関回転速度NEを検出する。そして、S308では、機関回転速度NEが所定範囲内($NE_L \leq NE \leq NE_H$)であるか否かを判別し、図10に示すように、機関負荷TPと機関回転速度NEとがそれぞれ所定範囲内である運転領域として予め特定されているリーン燃焼領域に該当しているか否かを判別する。

【0028】前記リーン燃焼領域に該当している場合には、S309へ進み、スロットルセンサ15によりスロットル弁開度TVOを検出する。S310では、スロットル弁開度TVOが所定開度TVOH以下であるか否かを判別し、所定開度TVOH以下であれば、S311へ進む。S311では、車速VSPを検出し、次のS312では、車速VSPが所定速度VSPL以上であるか否かを判別する(図11参照)。

【0029】そして、車速VSPが所定速度VSPL以上であれば、S313へ進み、車速VSPの変化率 ΔVSP を検出する。S314では、前記変化率 ΔVSP が所定値DVH(図11参照)以下であるか否かを判別し、車速VSPが略安定しているときには、S315へ進み、リーン運転許可フラグFLEANに1をセットする。

【0030】一方、上記条件のうちの1つでも満足しない条件がある場合には、S316へ進んで、前記リーン運転許可フラグFLEANに0をセットする。図4のフローチャートに示すルーチンは、前記リーン運転許可フラグFLEANに基づく燃空比制御の様子を示すものである。この図4のフローチャートにおいて、まず、S401では、前記リーン運転許可フラグFLEANの判別を行う。

【0031】そして、リーン運転許可フラグFLEANが1であるときには、S402へ進み、目標燃空比TDM_Lを、リーン燃空比マップを参照して求める。一方、前記リーン運転許可フラグFLEANが0であるときには、S403へ進み、目標燃空比TDM_Lを、ストイキ燃空比(理論空燃比)マップを参照して求める。

【0032】S404では、再度前記リーン運転許可フラグFLEANを判別し、リーン運転許可フラグFLEANが1であるときには、S405へ進んで、燃空比補正係数DMLを、

$$DML = \max(DML - \Delta DML, TDM_L)$$

として設定する。

【0033】前記 ΔDML は、図12に示すように、スロットル弁の開度変化率 ΔTVO が大きいときほど大きな値として設定される燃空比補正係数DMLのステップ変化量であり、リーン運転許可フラグFLEANが0の状態から1に変化すると、前記 ΔDML による変化速度で、目標燃空比TDM_Lにまで徐々にリーン化されるようになる。

【0034】一方、リーン運転許可フラグFLEANが0であるときには、S406へ進んで、燃空比補正係数DMLを、

$$DML = \min(DML + \Delta DML, TDM_L)$$

として設定する。即ち、リーン燃焼状態からストイキ(理論空燃比)に切り換えるときには、前記 ΔDML による変化速度で、目標燃空比TDM_Lにまで徐々にリッチ化されるようになる(図12参照)。

【0035】S407では、前記燃空比補正係数DMLが1.0であるか否かを判別し、前記燃空比補正係数DMLが1.0であって、理論空燃比での燃焼を行わせるときには、そのまま本ルーチンを終了させる。一方、S407で前記燃空比補正係数DMLが1.0でないと判別されたときには、理論空燃比に実際の空燃比を近づける空燃比フィードバック制御を行わないので、S408へ進んで、空燃比フィードバック補正係数ALPHAを1.0にクランプする。

【0036】図5のフローチャートに示すルーチンは、前記NO_x吸着触媒6におけるNO_x吸着量を算出するものである。尚、この図5のフローチャートに示す機能が、NO_x吸着量算出手段に相当する。S501では、前記燃空比補正係数DMLが1.0未満であるか否かに基づいてリーン燃焼状態であるか否かを判別する。

【0037】燃空比補正係数DMLが1.0未満であってリーン燃焼されているときには、前記NO_x吸着触媒6にNO_xが吸着されることになるので、S502へ進んで、NO_x吸着速度DABSRを下式に基づいて推定する。

$$DABSR = DABSR0 \# \times TP / TP0 \times Q / Q0 \times (ABSFC\# - ABSTC) / ABSFC\#$$

ここで、DABSR0#は基準吸着速度、TP0は基準

負荷、 Q_0 は基準空気量、 $ABSTC\#$ は最大吸着量、 $ABSTC$ は現時点における吸着量であり、負荷 TP が大きいほど、また、吸入空気量 Q が大きいほど吸着速度 $DABSR$ を大きく推定し、更に、吸着量 $ABSTC$ が多くなるほど吸着速度 $DABSR$ を遅く推定する構成としてある。

【003-8】次のS503 では、前記吸着速度 $DABSR$ を用いて現時点における NO_x 吸着量 $ABSTC$ を下式に従って推定する。

$$ABSTC = ABSTC (\text{old}) + DABSR$$

一方、S501 で燃空比補正係数 DML が1.0 未満でないと判別されたときには、理論空燃比燃焼時であり、前記 NO_x 吸着触媒6 に吸着されていた NO_x が放出されることになるので、S504 で NO_x 脱離速度 $DPRGR$ を下式に従って推定する。

$$[003-9] DPRGR = DPRGR0 \# \times T_P / T_P \\ 0 \times Q / Q_0 \times ABSTC / ABSFC \#$$

ここで、前記 $DPRGR0 \#$ は、基準の脱離速度である。S505 では、前記脱離速度 $DPRGR$ を用いて現時点における NO_x 吸着量 $ABSTC$ を下式に従って推定する。

【004-0】

$$ABSTC = ABSTC (\text{old}) - DPRGR$$

図6のフローチャートに示すルーチンは、空燃比フィードバック制御を示すものであり、機関の1回転毎に実行されるようになっている。尚、この図6のフローチャートに示す機能が、空燃比フィードバック制御手段、リッチ化手段、リッチ化度合い制御手段に相当する。

【004-1】S601 では、前記燃空比補正係数 DML が1.0 未満であるか否かに基づいてリーン燃焼状態であるか否かを判別する。リーン燃焼時であるときには、S610 でリッチ化実行フラグ $FRSFT$ に1をセットし、S611 で空燃比フィードバック補正係数 $ALPHA$ を1.0 にクランプして本ルーチンを終了させる。

【004-2】一方、前記燃空比補正係数 DML が1.0 であって、理論空燃比燃焼時であるときには、S602 へ進み、所定のクランプ条件が成立しているか否かを判別し、理論空燃比燃焼時であっても、所定のクランプ条件が成立しているときには、S611 へ進んで、空燃比フィードバック補正係数 $ALPHA$ を1.0 にクランプして本ルーチンを終了させる。

【004-3】クランプ条件が成立していない場合には、S603 へ進み、前記リッチ化実行フラグ $FRSFT$ に1 がセットされているか否かを判別する。前記リッチ化実行フラグ $FRSFT$ が0 であるときには、S612 に進み、前記空燃比フィードバック補正係数 $ALPHA$ の比例積分制御に用いる積分分 i 、比例分 PR 、 PL (図13参照) をそれぞれマップを参照して求める。

【004-4】そして、S609 へ進み、酸素センサ13で検出される理論空燃比に対する実際の空燃比のリッチ・リ

ーンに基づいて、空燃比フィードバック補正係数 $ALPHA$ の比例積分制御する。一方、S603 でリッチ化実行フラグ $FRSFT$ が1 であると判別されたときには、S604 へ進み、 NO_x 吸着量 $ABSTC$ に従ってリッチ化度合 LRL を設定する。ここで、 NO_x 吸着量が多いときほど、これが脱離したときに還元するのに必要な HC 量が多くなるため、 NO_x 吸着量が多いときほどリッチ化度合 LRL を大きく設定するようにしてある。

【004-5】次のS605 では、機関負荷 TP 及び回転速度 NE に従ってマップからリッチ化度合学習補正係数 $LRLHS$ を参照する。前記リッチ化度合学習補正係数 $LRLHS$ の学習設定については後述するが、 NO_x 吸着触媒6 及び三元触媒7 の下流側に設けられる NO_x 濃度検出手段としての NO_x 濃度センサ17による NO_x の濃度の検出結果に基づいて学習されるようになっている。

【004-6】S606 では、空燃比フィードバック補正係数 $ALPHA$ の比例制御による増大設定に用いる比例分 PL (図13参照) を、

$$PL = LRL \times LRLHS$$

として設定すると共に、減少比例制御に用いる PR を0 にする。更に、補正係数 $ALPHA$ の積分制御に用いる積分分 i として所定値 $LRI \#$ をセットする。

【004-7】上記のように補正係数 $ALPHA$ の比例制御による増大設定に用いる比例分 PL (比例操作量) を増大設定することで、リーン→ストイキ切り換え時に空燃比を一時的にリッチ化するものであり、かかるリッチ化をフィードバックの1周期だけ実行したか否かをS607 で判別し、1周期間だけリッチ化すると、S608 へ進んで前記リッチ化実行フラグ $FRSFT$ に0をセットして、その後は、通常のフィードバック制御が行われるようにする。

【004-8】図7のフローチャートに示すルーチンは、前記リッチ化度合学習補正係数 $LRLHS$ の学習の様子を示すものであり、前記図6のフローチャートに基づくリッチシフト終了後、即ち、リッチ化実行フラグ $FRSFT$ が1から0に切り換えられたときに毎回実行されるようにしてある。尚、この図7のフローチャートに示す機能も、リッチ化度合い制御手段に相当する。

【004-9】S701 では、機関負荷 TP 、回転速度 NE などの運転条件を検出する。S702 では、 NO_x 吸着量 $ABSTC$ 及び吸入空気量 Q に基づいて、リーン→ストイキ切り換え時における NO_x 排出量の目標値 $SLTNNOX$ を求める。S703 では、後述する図8のフローチャートに従って求めたリーン→ストイキ切り換え時における実際の NO_x 排出量 $TALNOX$ が、前記目標値 $SLTNNOX$ から所定値 $HYSNNOX \#$ を減算した値以下であるか否かを判別する。

【005-0】実際の NO_x 排出量 $TALNOX$ が、前記目標値 $SLTNNOX$ を大きく下回っている場合には、S

704 へ進んで、マップの該当領域からリッチ化度合学習補正係数L R P L H S を参照する。そして、S 705 では、前記補正係数L R P L H S を所定値D P L #だけ減少補正し、次のS 706 では、かかる減少補正後の補正係数L R P L H S にマップデータを書き換える。

【0051】即ち、NOx 排出量が目標を大きく下回っている場合には、リッチ化度合いを減少させても、NOx 排出量を目標以下に抑制できる可能性があるので、過剰なリッチシフトを回避すべく補正係数L R P L H S を減少させるものである。一方、S 703 で、実際のNOx 排出量T A L N O X が、前記目標値S L T N O X から所定値H Y S N O X #を減算した値を越えていると判別されたときには、S 707 へ進み、実際のNOx 排出量T A L N O X が、前記目標値S L T N O X に所定値H Y S N O X #を加算した値以上であるか否かを判別する。

【0052】そして、実際のNOx 排出量T A L N O X が、前記目標値S L T N O X に所定値H Y S N O X #を加算した値以上である場合には、S 708 へ進み、マップから現状の補正係数L R P L H S を読み出し、S 709 では、読み出した補正係数L R P L H S を所定値D P L #だけ増大補正し、S 710 では前記増大補正した補正係数L R P L H S に基づいてマップデータを更新する。

【0053】即ち、実際のNOx 排出量T A L N O X が、目標値を大きく上回る場合には、リッチ化度合いが少なく、NOx の浄化に必要とされるHC量が不足しているものと推定されるので、リッチ化度合いを大きくしてHC量を増大させるべく、前記補正係数L R P L H S を増大補正するものである。一方、実際のNOx 排出量T A L N O X が、目標値S L T N O X ± H Y S N O X #の範囲内であるときには、現状のリッチシフト量が適正であると判断して、マップデータの更新を行うことなく本ルーチンを終了する。

【0054】図8のフローチャートに示すルーチンは、前記NOx 排出量T A L N O X を求めるためのルーチンであり、このフローチャートに示す機能が、NOx 排出量算出手段に相当する。S 801 では、前記燃空比補正係数D M L が1.0 以上であるか否かに基づいてストイキ燃焼状態であるか否かを判別する。

【0055】前記燃空比補正係数D M L が1.0 以上であってストイキ燃焼時であるときには、S 802 へ進み、累積空気量の目標値Q R を、前記NOx 吸着量A B S T C に基づいて設定する。即ち、リーン→ストイキ切り換え後の実際の吸入空気量の累積値Q S U M が前記目標値Q R に達するまでに排出されたNOx 排出量の総量を求るものであり、NOx 吸着量A B S T C が多いときほど、前記目標値Q R を大きく設定する。

【0056】S 803 では、リーン→ストイキ切り換え後の吸入空気量の累積Q S U M が、前記目標値Q R 以上になつたか否かを判別し、目標値Q R に達していない場合には、S 804 へ進む。S 804 では、前記NOx 濃度セン

サ17で検出された触媒6, 7下流側（触媒出口）でのNOx 濃度C N C N O X を読み込む。

【0057】S 805 では、エアフローメータ14で検出された吸入空気量Q を読み込む。S 806 では、NOx 排出量T A L N O X を、下式に従って求める。

$$T A L N O X = T A L N O X + Q \times C N C N O X$$

S 807 では、累積空気量Q S U M を、下式に従って求める。

$$Q S U M = Q S U M + Q$$

一方、前記燃空比補正係数D M L が1.0 未満であると判別されるリーン燃焼時には、S 808 へ進み、前記累積空気量Q S U M 及びNOx 排出量T A L N O X をそれぞれゼロリセットし、リーン→ストイキ切り換え後の累積空気量Q S U M 及びNOx 排出量T A L N O X が求められるようにする（図14参照）。

【0058】

【発明の効果】以上説明したように請求項1記載の発明によると、NOx 吸着触媒からNOx が脱離されるときに、空燃比を一時的にリッチ化して、NOx の還元処理に必要とされるHC量の確保を図る構成において、NOx 濃度に基づいて前記リッチ化の度合いを制御するから、リッチ度合いを適正に制御して過剰なリッチ化によるHC量の増大、及び、過少なリッチ化によるNOx 量の増大を確実に回避できるという効果がある。

【0059】請求項2記載の発明によると、運転条件が変化しても、各運転条件において適正なリッチ化制御を実行させて、安定的にNOx 濃度を低く制御でき、また、過剰なリッチ化によってHC量が増大することを回避できるという効果がある。請求項3記載の発明によると、NOx 濃度からNOx 排出量を求めるので、NOx 排出量が許容値を越えるようになることを回避しつつ、過剰なリッチ化を回避できるという効果がある。

【0060】請求項4記載の発明によると、NOx 排出量と共に、NOx 吸着量を求めるから、NOx 吸着量に応じて異なるNOx 排出量の許容に対応した制御が行え、また、NOx 吸着量に応じて予め適正レベルに比較的近いリッチ化度合いを制御を行わせることが可能となるという効果がある。請求項5記載の発明によると、NOx 吸着量の総量と吸入空気量とにに基づいて許容されるNOx 排出量の総量が目標値として設定され、かかる目標値に実際のNOx 排出量が一致するような適正なリッチ化度合いを設定できるという効果がある。

【0061】請求項6記載の発明によると、NOx 吸着量の総量に基づいてリッチ化度合いの基本値が設定されるから、NOx 排出量の総量に基づきリッチ化度合いを高精度に修正する前であっても、NOx が多量に排出されてしまうことを回避できるという効果がある。請求項7記載の発明によると、NOx 吸着触媒に吸着されていて脱離されたNOx の総量を精度良く求めることができるという効果がある。

【0062】請求項8記載の発明によると、脱離されたNO_xを還元するために空燃比を一時的にリッチ状態にしても、その後、目標空燃比付近の状態へと滑らかに変化させることができるという効果がある。

【図面の簡単な説明】

【図1】請求項1記載の発明の基本構成を示すブロック図。

【図2】内燃機関のシステム構成図。

【図3】リーン運転制御を示すフローチャート。

【図4】燃空比制御を示すフローチャート。

【図5】NO_x吸着量の推定演算を示すフローチャート。

【図6】空燃比フィードバック制御を示すフローチャート。

【図7】リッチ化度合いの学習制御を示すフローチャート。

【図8】NO_x排出量の推定演算を示すフローチャート。

【図9】リーン運転条件としての水温範囲を示す図。

【図10】リーン運転領域を示す図。

【図11】リーン運転条件としての車速と車速変化率とを

示す図。

【図12】燃空比制御の様子を示すタイムチャート。

【図13】空燃比フィードバック制御の様子を示すタイムチャート。

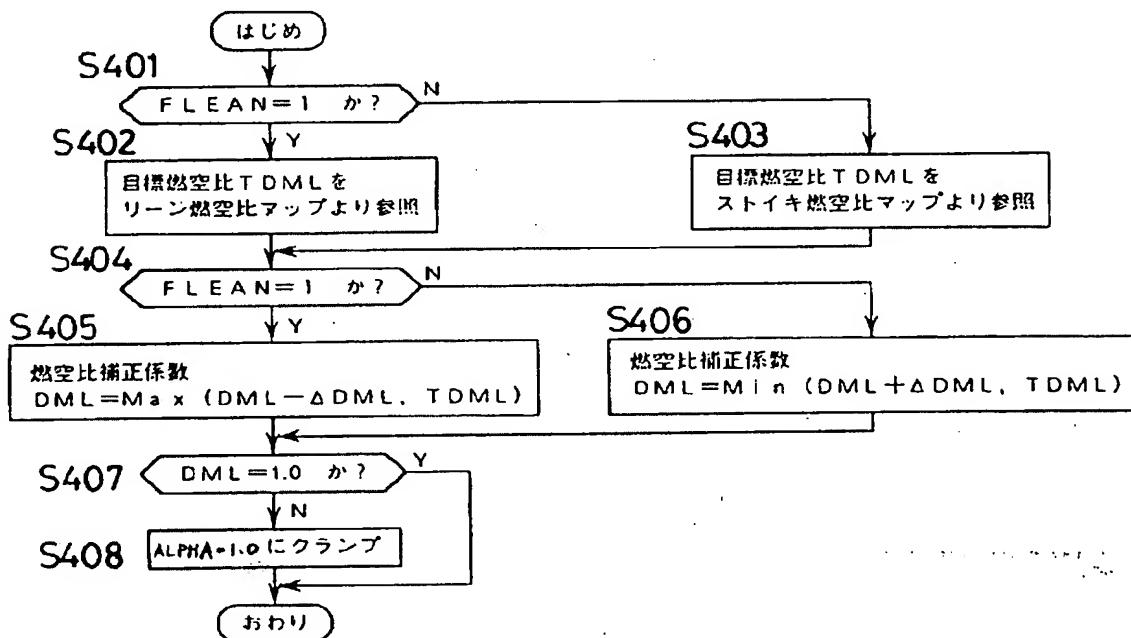
【図14】NO_x排出量の変化を示すタイムチャート。

【図15】リッチ化度合いとNO_x濃度との相関を示す線図。

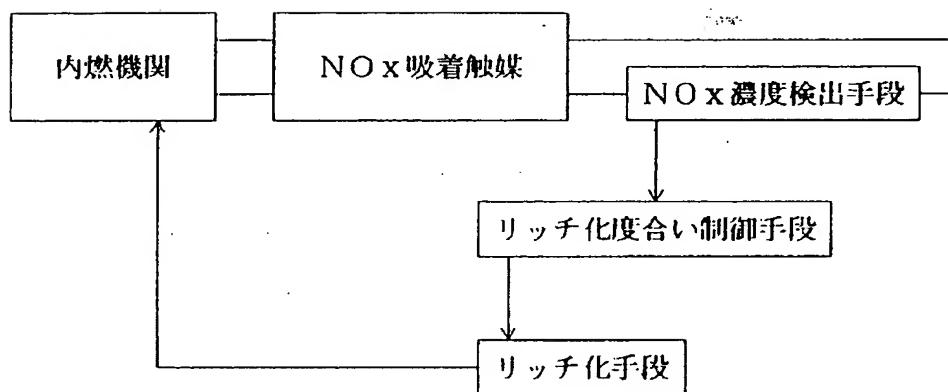
【符号の説明】

1	内燃機関
3	スロットル弁
4	燃料噴射弁
5	点火栓
6	NO _x 吸着触媒
7	三元触媒
9	コントロールユニット
11	クラシク角センサ
12	水温センサ
13	酸素センサ
14	エアフローメータ
15	スロットルセンサ
17	NO _x 濃度センサ

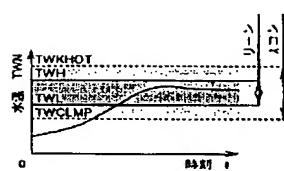
【図4】



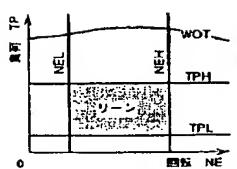
【図 1】



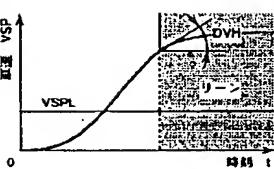
【図 9】



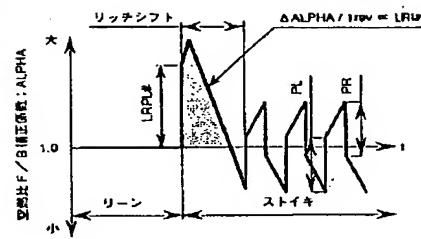
【図 10】



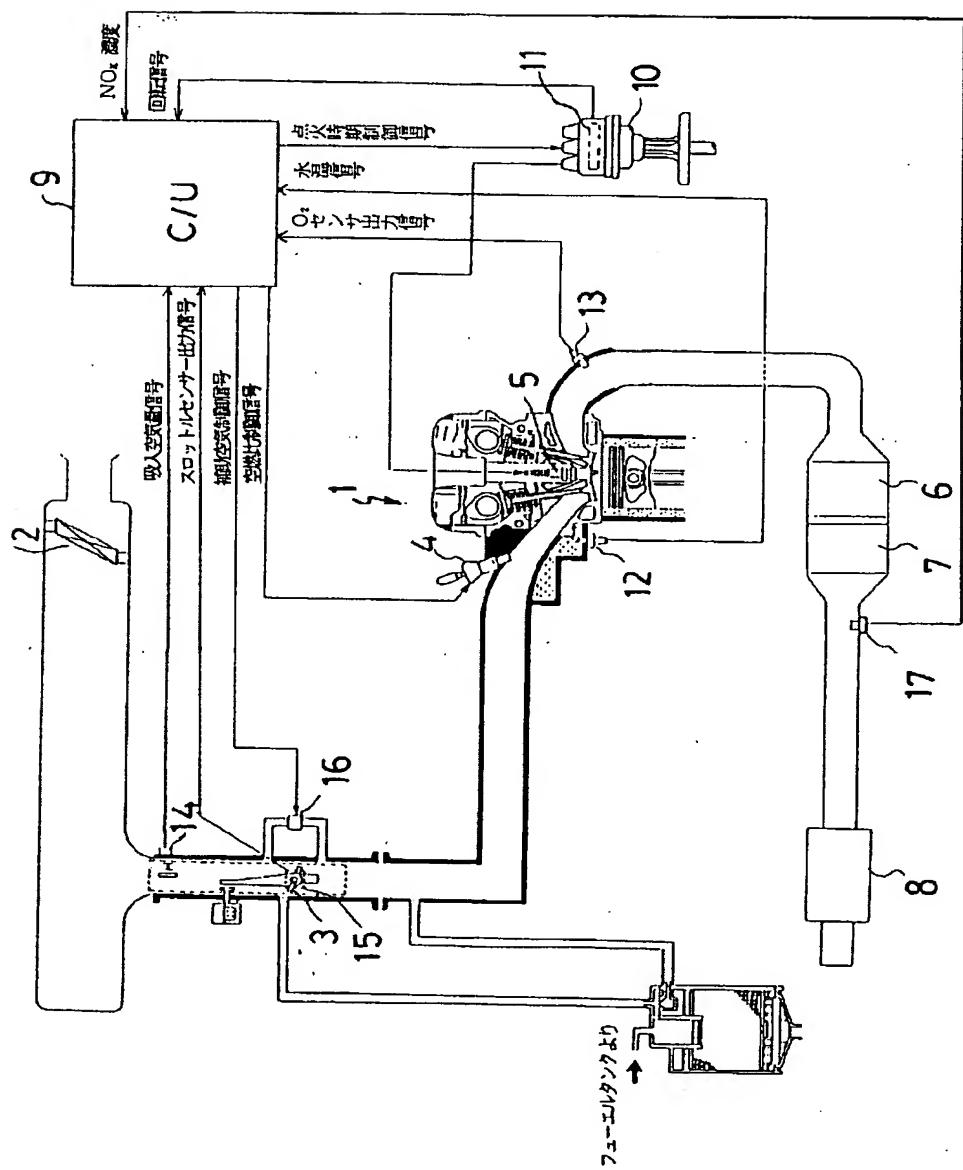
【図 11】



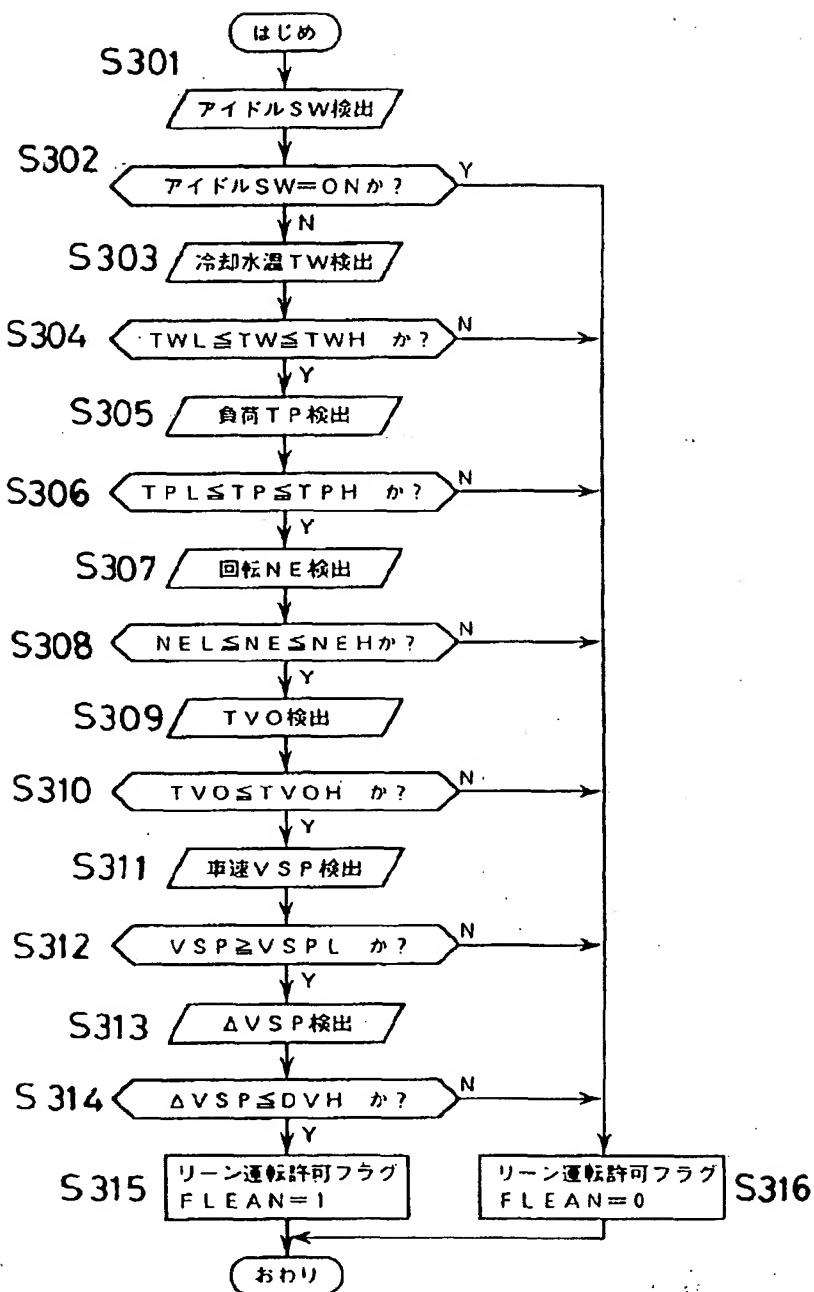
【図 13】



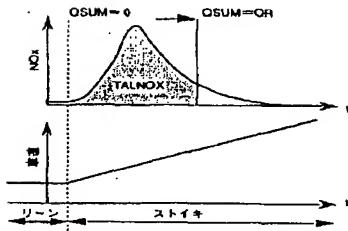
【図2】



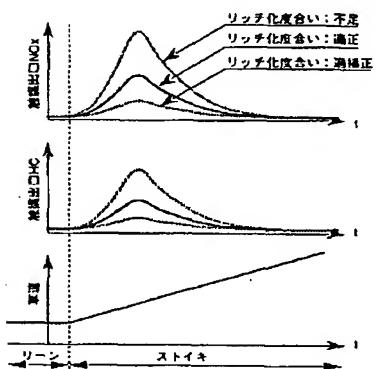
【図3】



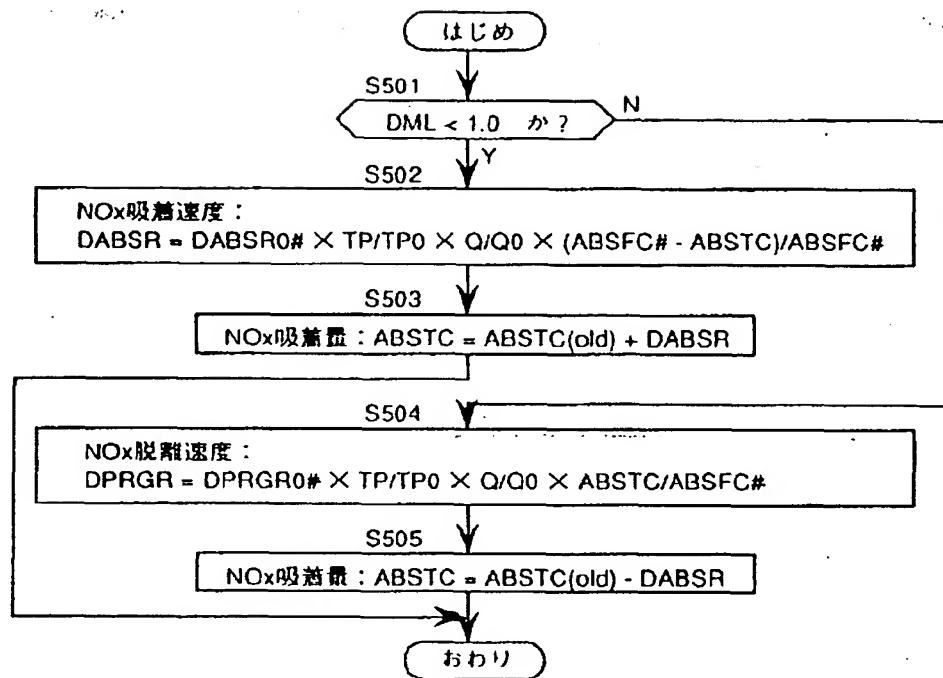
【図14】



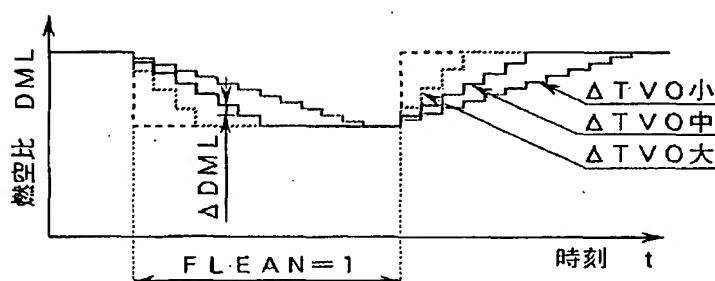
【図15】



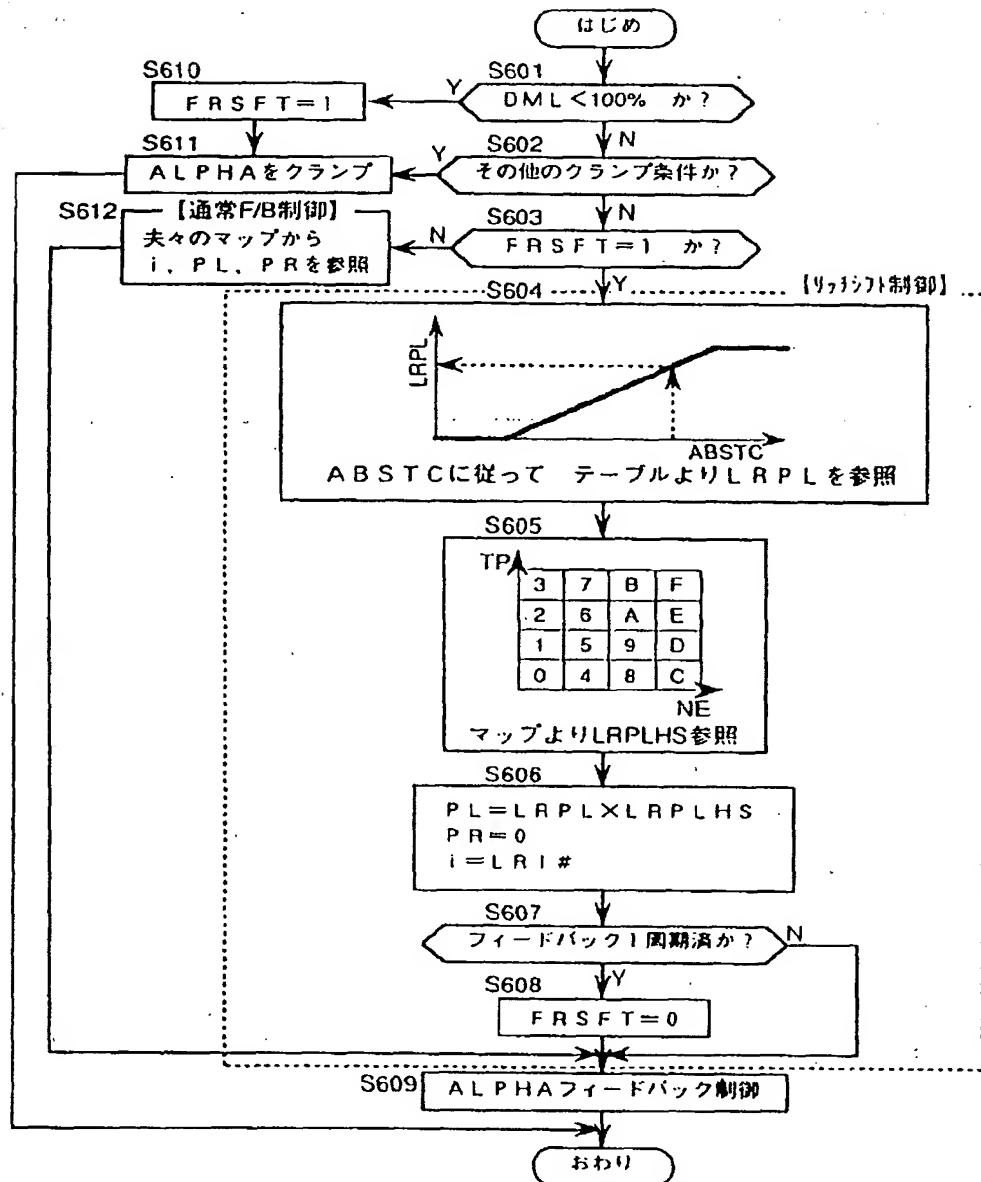
【図5】



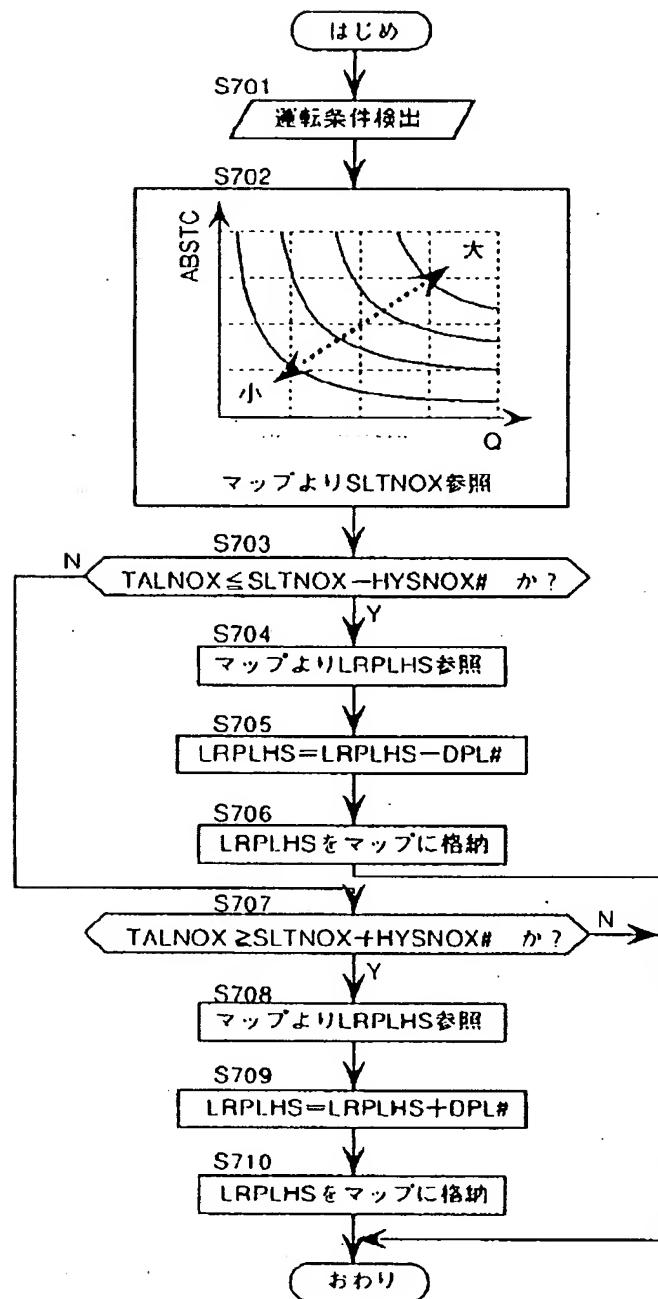
【図12】



【図6】



【図7】



【図8】

